INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 23, No. 3, p. 87-95, 2023

RESEARCH PAPER OPEN ACCESS

Species richness and conservation status of ferns and lycophytes in Sibagat, Agusan del Sur, Caraga Region, Philippines

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Key words: Biodiversity, IUCN, Caraga, Pteridophytes, Endemicity

http://dx.doi.org/10.12692/ijb/23.3.87-95 Article published on September 04, 2023

Abstract

Ferns and lycophytes play an essential role in the environment and provide substantial benefits to human consumption. This study aimed to determine the species richness and conservation status of ferns and lycophytes in Brgy. Tabon-Tabon, Sibagat, Agusan del Sur, Caraga Region, Philippines. Three stations were established and measured 30m x 30 meters. Inside each station, a 1m × 1m plot is built with an interval of 1 meter. Results show that thirteen thousand eighty-four (13,084) individuals belonging to six species under five families were recorded. There were six species *Nephrolepis cordifolia, Nephrolepis biserrata, Davalia solida, Diplazium esculentum, Tectaria athyriosora* and *Selaginella delicatula* categorized as Least Concern (LC) by the International Union for Conservation of Nature (IUCN). While five species *Nephrolepis cordifolia, Diplazium esculentum, Davallia solida, Tectaria athyriosora,* and *Selaginella delicatula* are considered Philippine endemic. On the other hand, two species *Tectaria athyriosora* and *Nephrolepis cordifolia* were Mindanao endemic. It indicates that the sampling area demonstrates the richness of ferns and lycophytes based on the observed species. Thus, the significance of the study provides baseline information on which the sampling area must be adequately managed to conserve the fern species further.

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Introduction

Ferns play an essential role in the environment and for humans. These plants are often neglected but of great help in maintaining the balance of the environment as being one of the primary sources of the food chain (Catapang *et al.*, 2012). The Philippines is the home of several species of ferns (Amoroso *et al.,* 1996). Around 930 species were recorded, of which more than 50 were known to have potential economic value and 296 species were endemic in the Philippines (Zamora and Co, 1986).

Ferns and lycophytes are valuable to the environment and humans in many ways. Hence, it is important to assess the abundance, potential benefits to the people and the ecological significance. However, in the present time, they are recognized for their appealing qualities (Banaticla and Buot, 2004). They are utilized for medical use (Yong, 2010), helps restore forests, (Magtoto and Austria, 2017), and ornaments (Amoroso, 2012). Further, it is considered as a factor that influences biodiversity distributions and community compositions (Amoroso, 2007).

In terms of medicine, there are still unexploited botanical properties and bioactive components (Amoroso *et al.,* 2014) which are significant, for it has potential in treating diseases and bioremediation (Yong *et al.*, 2010). Accordingly, there are still areas in the Philippines with no available data on this species. Most people usually identify ferns as non-ecologically significant (Amoroso *et al.*, 2016).

The rapid growth of the plant caused the problem to most people, and its uses are generally disregarded. Ferns and allies have their shared life cycle as spore-producing plants, which included them to the pteridophytes (Amoroso *et al.*, 2016).

A study conducted by Smith *et al.*, 2006 showed molecular data, which has exposed those pteridophytes as paraphyletic. They are now known as lycophytes and ferns (i.e., monilophytes), which include horsetails, whisk ferns and all eusporangiate and leptosporangiate ferns.

The variety of vascular plants in the Philippines involves an estimation of 1,100 species of ferns and lycophytes distributed among 154 genera and 34 families, according to new classifications (Smith *et al.,* 2006). Further, the study shows that the estimation continues to grow due to new findings of species and reports in the Philippines (Amoroso *et al.,* 2009; Barcelona *et al.,* 2013). Thus, the present study aims to determine the species richness and conservation status of ferns and lycophytes in Brgy. Tabon-Tabon, Sibagat, Agusan del Sur, Caraga Region, Philippines, hence it is the baseline information since no study yet has been conducted in the area.

Materials and methods

Description of the area

This study was conducted in Brgy. Tabon-Tabon, Sibagat, Agusan del Sur, Philippines (Fig.1). Geographically lies between $8^0$52'45"N $125^0$42'03" E.

The study area was surrounded by mountains. The ferns and lycophytes were located near a stream with cold temperatures. Specimen collection was done in April 2019.

Plant sample procedures

Three stations (S1, S2, S3) were established and measured in 30m x 30m with an interval of 10m from each station. In each station, another measurement of 1m x 1m plots was undertaken with a range of 1 meter. In each 1m x 1m plot, different species of ferns and lycophytes were found and documented. Each plant sample was placed in a newspaper and was applied with denatured alcohol to preserve it. The pressing method was also done for species identification and preservation. Further, the plant sample was labeled according to the station where it was collected. Each specimen was captured using a digital camera (13 megapixels) for recording purposes.

Species identification

The collected plant samples were submitted to Caraga State University-Main Campus, Ampayon, Butuan City for specimen identification.

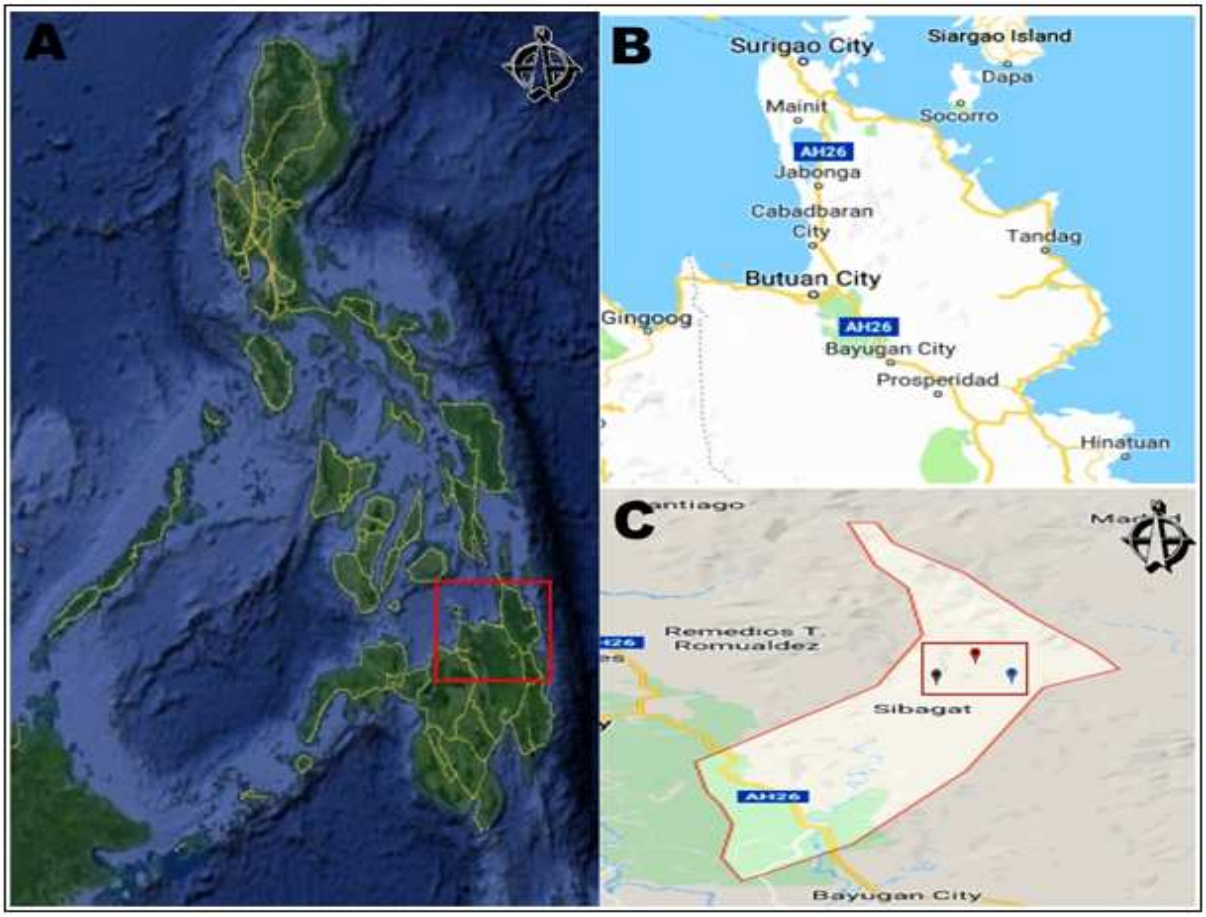

Fig. 1. Map of the sampling area. A. Philippines B. Caraga Region C. Sampling Area, Brgy. Tabon-Tabon, Sibagat, Agusan del Sur, Philippines.

The captured images of the plant samples were sorted according to their species level. The determination of the families and genera of each fern or lycophytes were completed by referring to the following monographs, floras and other publications for the classification systems used in this study (Smith *et al.,* 2006, 2008, Lehtonen *et al.,* 2010, Rothfels *et al.,* 2012, Labiak *et al.,* 2014, Amoroso, *et al.*, 2016).

Status Determination of Ferns and Lycophytes

The national list of threatened Philippine plants (Fernando *et al.,* 2008; Amoroso *et al.,* 2015) shown in Table 1 was used for the evaluation of the conservation status of the species documented. It follows the criteria of the International Union for the Conservation of Nature (IUCN) (e.g., critically endangered, endangered, vulnerable, and Least Concern or LC). This also includes the ecological status (e.g., Philippine endemic and Mindanao endemic). This information served as the basis for the government agencies that set the conservational strategy of Protected Area Management Board (PAMB), Department of Environment and Natural Resources (DENR), and Local Government Unit (LGU) to assess and protect threatened species in all areas.

Results and discussion

The collected plant species of ferns and lycophytes are shown in Table 2. There were five ferns species recorded across the stations: *Nephrolepis cordifolia, Nephrolepis biserrata, Davalia solida, Diplazium esculentum*, and *Tectaria athyriosora*) while 1 was a lycophyte *Selaginella delicatula*. A total of 13,084 individuals of ferns and lycophytes were documented among three stations. Station 1 has the highest number of individuals (5,033) followed by station 2 (4,653) and station 3 (3,456), respectively. Further, *D. esculentum* or locally known as "Pako" recorded the maximum number of individuals among the three

stations. The species is native in the Philippines and has been abundant in the Southern parts of Luzon likewise in the entire Central Visayas region. (Tongco, *et al.,* 2014). It could also be because of their spores that germinate and develops rapidly. Moreover, *D. esculentum* grows best on soil with organic matter (Huxley, 1992). On the other hand, *N. biserrata* has 1,839 individuals; *N. cordifolia* (1,667), *T. athyriosora* (1,610), and *D. solida* (1,475). While *S. delicatula* has the lowest number of individuals (1, 067), it was associated that this grows in humid and cold areas, but a recent study shows it is threatened by natural degradation and global warming (Setyawan, 2011).

Table 1. Categories used for the evaluation of the conservation status of plants from International Union for the Conservation of Nature (2013).

Categories	Description
Critically Endangered (CR)	Species population reduced to at least 80% within the next 10 years or 3 generations
Endangered (EN)	Species population reduced to at least 50 % within the next 10 years or 3 generations
Vulnerable (VU)	Species population reduced to at least 20 % within the next 10 years or 3 generations

Nonetheless, the family Nephrolepidaceae adapts well to different soil types, bears full sun, drought-tolerant, and spreads quickly in humid garden conditions (Riefner *et al.,* 2015). Likewise, the family of Davalliaceae, Athyriaceae, and Tectariaceae is one of the highest fern families found in the Philippines (Delos Angeles, 2012). Based on a classification scheme, these families can be found in wet tropic areas extending to the north and temperate zones (Smith's 2006; Parris, 2007).

Table 2. Number of Ferns and Lycophyte documented in Brgy. Tabon-Tabon, Sibagat, Agusan del Norte, Sibagat, Caraga Region, Agusan del Sur, Philippines.

Species	Common Name	Family	Station 1	Station 2	Station 3
Nephrolepis cordifolia	Erect sword fern	Nephrolepidaceae	688	641	338
Nephrolepis biserrata	Giant sword fern	Nephrolepidaceae	794	590	515
Davallia solida	Rabbit's foot fern	Davalliaceae	880	389	206
Diplazium esculentum	Pako	Athyriaceae	1,633	2,025	1,766
Tectaria athyriosora	Halberd fern	Tectariaceae	595	654	361
Selaginella delicatula	Spikemoss	Selaginellaceae	443	354	270

The family Athyriaceae was said to be endemic to Taiwan until recently it was found in the Philippines. Accordingly, the family Athyriaceae is distributed in temperate and tropical-subtropical regions of Asia (Liu *et al*., 2008). From the same study conducted by (Mannan *et al.,* 2008), ferns that are used as a food source are the young fronds of *D. esculentum*, and the rhizome and young shoots of *N. biserrata*. Both can be consumed as a salad or vegetable. For medicine uses, the fronds of *N. cordifolia* can ease a cough, and its paste is used as an anti-inflammatory in wounds (Delos Angeles *et al.,* 2012). While, *D. esculentum* for constipation, fever (Amit *et al.,* 2012) and *S. delicatula* as an antioxidant, anti-cancer, and anti-inflammatory (Setyawan, 2011). The rest of the ferns and lycophytes could be used as ornaments (Mannan *et al.*, 2008). Moreover, the change of climate has an effect on particular species that causes them to move from another place to another. (Sandel *et al.,* 2011). Ecological advancement in terms of nutrients composition could also lead to plant composition i.e., abundance and richness. Indeed, *D. esculentum* exhibits the most number of individuals in the area (Fig. 2).

While other fern species show the least number of individuals recorded hence species abundance was connected with topographical consideration. Thus, the biodiversity of species often associated with geographic regions.

Table 3. Total number of Ferns and Lycophytes in different locations of the Philippines (Amoroso, *et al.*, 2016).

Location	Total Number of Species	References
Karst Forest, Bohol Island	169	Barcelona *et al.*, 2006
Mt. Bali-it, Balbalasang-Balbalan National Park, Northern Luzon	167	Barcelona, 2003a
Mt. Marilog, Davao City	165	Amoroso *et al.*, 1996
Mt. Pinamantawan, Quezon, Bukidnon	121	Sumagaysay, 2012
Mt. Iraya and vicinity, Batan Island, Batanes	89	Barcelona, 2003b
Mt. Pangasuan, Leyte	94	Belonias and Banoc, 1994
Pasonanca Natural Park, Zamboanga City	72	Andas, 2015
Mt. Malukot, Batangas, Southern Luzon	40	Catapang *et al.*, 2012
Panay Island	228	Barcelona, 2004
Mt. Burnay and vicinity, Northern Luzon	199	Ebihara *et al.*, 2002
Mt. Kitanglad, Bukidnon	439	Amoroso *et al.*, 2011a
Mt. Malindang, Misamis Occidental	280	Amoroso *et al.*, 2011b

Nonetheless, other factors may be attributed to species richness in the Philippines such as the sample size of the area, climatic conditions, soil type, and geographic location (Kessler, 2010). Changing land patterns from forests to agricultural or industrial lands and pollution are human activities that can also affect the richness of a species in an area (Amoroso *et al.*, 2016). Ferns and lycophytes are vascular plants that contribute significantly to the number of flora in tropical and subtropical mountains (Table 3).

They are different from woody plants for they spread through their small spores and begin a new population in distant localities.

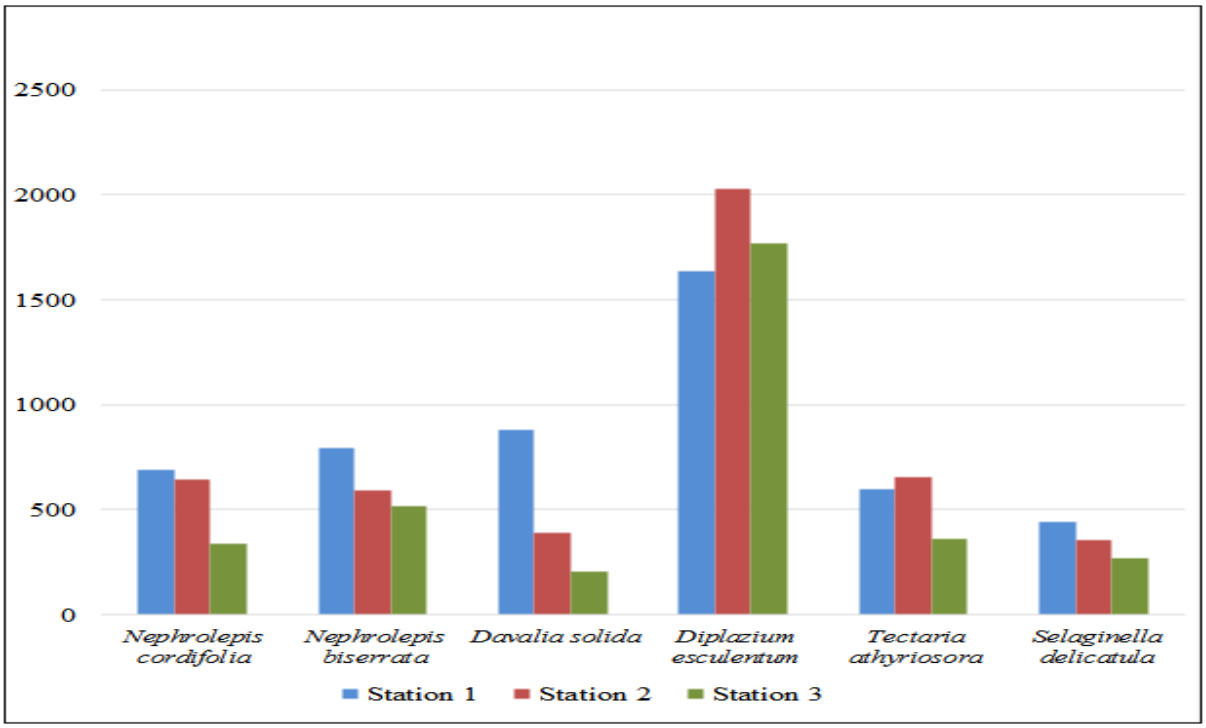

Fig. 2. Graph showing the number of species individuals across the three stations in Brgy. Tabon-Tabon, Sibagat, Agusan del Sur, Caraga Region, Philippines.

They show lower endemism, less numerous speciation, their growth form are mostly herbaceous perennial, need moisture, and their evolutionary history is extensive (Bhattarai *et al.*, 2004). Indeed, the sampling area Brgy. Tabon-Tabon, Sibagat, Agusan del Sur, Caraga Region, Philippines is identified where ferns and lycophytes can quickly grow due to the climatic condition (Fig. 3). The area is rich in species that can be used as a food source, as a medicine and as well as an ornamental entity. These plants offer substantial benefits to the environment and for human resources.

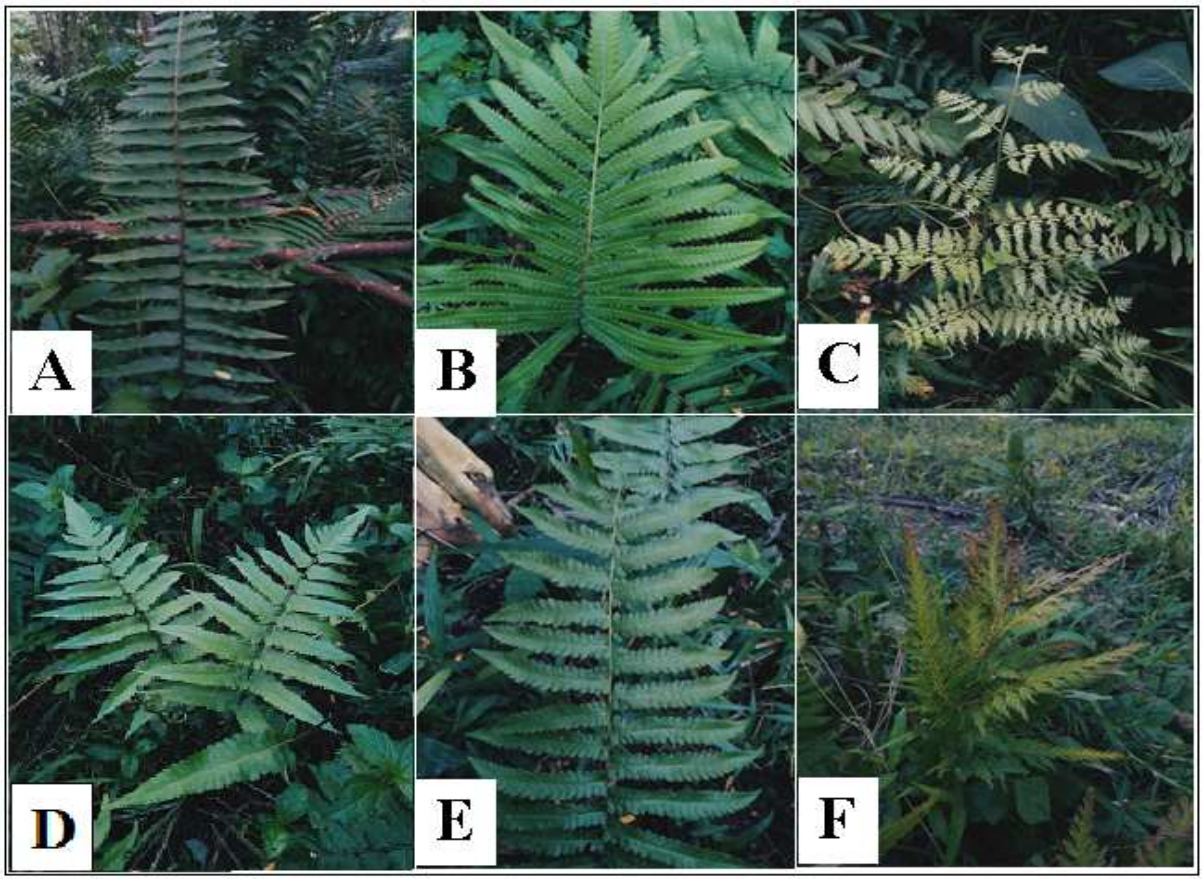

Fig. 3. Ferns and lycophytes documented in Brgy. Tabon – Tabon, Sibagat, Agusan del Sur, Caraga Region, Philippines. **A.** *Nephrolepis cordifolia* **B.** *Nephrolepis biserrata* **C.** *Davalia solida* **D.** *Diplazium esculentum* **E.** *Tectaria athyriosora* **F.** *Selaginella delicatula.*

Conclusion

Species Richness and Conservation Status of Ferns and Lycophytes in Brgy. Tabon-Tabon, Sibagat, Agusan del Sur, Philippines was determined. Results showed a total of six species under five families of ferns and lycophytes were recorded. The species with the most number of individuals was the *D. esculentum* locally known as "Pako" which is considered as a food source in the country. Based on the results, the collected fern species were under the category of Least Concern (LC) where five species *N. cordifolia, D. esculentum, D. solida, T. athyriosora*, and *S. delicatula* are considered as Philippine endemic while the two species *T. athyriosora* and *N. cordifolia* were Mindanao endemic. The significance of this study implies that assessing the diversity of ferns and lycophytes could be an indicator of ecological conditions wherein the plant community has an impact on ecological services as well as an economic resource in the specific locality.

Acknowledgment

The researchers would like to extend their gratitude to the parents for their financial support. Special thanks to Ms. Nelsa P. Egom for being the guide during the sampling process and to Dr. Meljan T. Demitillo, from the Biology Department of Caraga State University for the plant identification.

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