

Morphological Characteristics of Stem and Leaf of *Lygodium* Species in Palompon, Leyte Philippines: Basis for Species Diversification

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Abstract—*Lygodium*, locally known as “Nito” is a genus belonging to the fern family that grows abundantly in the Philippines. It is a vine growing as a secondary forest cover clinging to trees and rocks. This study generally aimed to conduct a preliminary study of *Lygodium* in Palompon, Leyte as basis for species diversification. Specifically, this study aimed to identify species of *Lygodium* based on leaf and stem morphological characteristics and determine the significant difference between altitude to the quantitative characteristics of *Lygodium* such as stem diameter and internode length. Six barangays were purposely identified based on geographical location with different altitudes. Ten whole plants of *Lygodium* were randomly taken from each site and were brought to the laboratory. Ten leaves out of the 60 samples that showed unique characteristics from the rest of the samples were again selected to be used in the identification of species. Quantitative morphological features, such as the diameter of the stem and length of the internode, of collected samples of *Lygodium* were also recorded as basis in determining the variations of *Lygodium* between taxa. The 2-way ANOVA was used in determining the relationship between altitude and stem diameter and internode length. Based on this study, there were two possible species found in Palompon, Leyte; the *Lygodium circinnatum* and *Lygodium palmatum*. One specie, the *Lygodium articulatum* would need further investigation and a more extensive study in order to prove that such species exist in Palompon, Leyte. The diameter of the stem and the Length of the internode of *Lygodium* depends on the location of each barangay but not on the altitude.

Keywords—*Lygodium circinnatum*, morphological study, Nito vine, Palompon.

I. INTRODUCTION

Ferns are once dominant terrestrial plant communities over the entire globe [Vogel et al. 1999] and are still present in most terrestrial ecosystems [Odland et al. 1995]. However, only a

few attempts have been made to model fern distributions from environmental characteristics [Pakeman and Marrs 1996], or to investigate broad scale patterns in fern diversity. Most studies of ferns have taken place in humid tropical regions where more

species are found [Poulsen and Nielsen 1995; Lwanga et al. 1998]. In addition, ferns are also good with which to address important issues related to the monitoring and restoration of biodiversity [Pearson 1995]. Ferns belong to *Pteridophytes* and are generally distributed along a lateral gradient, with the highest diversity in the tropics, mainly in mountainous area [Jacobsen and Jacobsen 1989; Kornas 1993; Linder 2001]. Habitat diversity, elevation, rainfall, temperature, and soils have all been suggested to explain *pteridophyte* richness and distribution [Moran 2002].

Lygodium, or climbing fern, is a genus of about 40 living species [Tyron and Tyron 1982] and a native to tropical regions across the world, with a few temperate species in eastern Asia and eastern North America. It is the sole genus in the family *Lygodiaceae*, though included in the family *Schizaeaceae* by some botanist. All species of the genus have an elongated climbing rachis (leaf stem) that have the capacity for indefinite growth, often reaching lengths of several meters. The plant is gathered from the wild and is used as food and medicine. The stems are used as tying material and are very popular for making baskets, hats, and other utility containers which are sold in markets.

Weaving is another skill of a typical Filipinos. In fact there are some parts of our country that are already engaged in the production of unique varieties of weaving products for domestic market only. Weaving industry can be one of the most promising sectors of huge employment. The abundance of the raw materials and the continuous supply of work force are contributing factors behind weaving industry. The manufacturing of weaving products can be remarkable contribution to the economic development of the municipality and to the national GDP and even in the exports revenues. However, this weaving industry has yet to receive nod from international audience because it is still in its infant stage for the time being as compared to the woodcraft industry.

The people of few barangays in the Municipality of Palompon used “Nito” as raw material for weaving products. If the said barangay folks are given additional knowledge and trainings as to increase the production of the said raw materials, then it can be an initial proceeding to a means of livelihood and a greater source of income.

The Nito vine must be gathered first then exposed to sunlight to dry. It does not need treatment like soaking,

scraping or hacking processes to enhance its natural beauty and color. The strip is taken from the innermost core of the stem, which is about the diameter of a pencil. The outermost layer of the stem has to be removed to get the strips. The raw strips are cleaned manually with a sharp improvised knife, taking at least two hours to clean a small bundle.

Hence, Nito processing has traditionally been a source of community livelihood in the rural areas.

II. OBJECTIVES

This study generally aimed to conduct a preliminary study of *Lygodium* in Palompon, Leyte as basis to species diversification.

Specifically, this study aimed to answer the following objectives:

- 1) To identify species of *Lygodium* based on leaf and stem morphological characteristics;
- 2) To determine the differences in quantitative characteristics of *Lygodium* species such as stem diameter and internode length based on altitude.

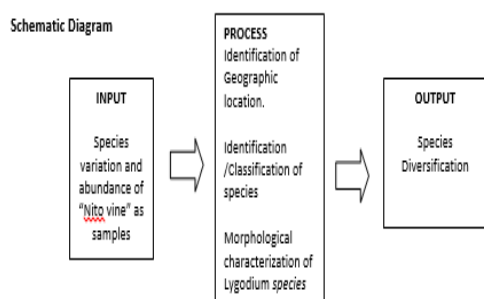


Figure 1. A schema in the preliminary study of *Lygodium* species on leaf and stem morphological characteristics as basis for species diversification.

Scope and Limitations of the Study

This study was conducted to determine the different *Lygodium* species found in an identified sampling sites. Environmental factor such as the altitude was also considered.

Due to time constraint, this study focused only on the taxonomic identification of *Lygodium* based on morphological features of stem and leaf. Identification of species was based on the reference materials. Further identification on its morphological features should be done on the next level of this study.

III. MATERIALS AND METHODS

Study Site

Palompon (11° 3' 0'' North, 124° 22' 59'' East) is a second class municipality in Leyte in Region VIII (Eastern Visayas), which is about 538 km south-east of Manila, Philippines (Figure 2). According to the 2010 census, it has a population of 54,163 people in 10, 710 households. It is administratively subdivided into 50 barangays; 9 make up the center of the town, and 41 are the outlying areas. The field work was conducted at the six hinterland barangays namely: Rizal, Lat-osan, Mazawalo, Taberna, San Isidro and San Miguel. Small scale farming activities of corn and root crops occurred in study sites located on the mountains and near riverbanks. The mountains and hills of Palompon where *Lygodium* was taken for study were just accessible by any means of transportation. Some *Lygodium* species can be directly recognized on the hillsides along the national road.

The vegetation present in the study sites was generally composed of tall trees commonly known as narra, mahogany, acacia, coconut, and some fruit-bearing trees. Wild bushes, ferns, weeds, and mosses could also be found covering the ground area.



Figure 2. (A) Map of the Philippines with red arrow pointing the Province of Leyte. (B) Map of Leyte highlighting the municipality of Palompon. (C). The boundaries of Palompon



Figure 3. Map of the Palompon Municipality. Study sites are marked with a red star.

Selection of the Sampling Sites

The six barangays chosen as study sites were purposely identified based on geographical location. Each site was located in different altitudes, as shown in Table 1. Prior to the selection of sampling site and to be certain if “Nito” vine exists in that specific barangay, a survey was conducted by distributing questionnaires to the barangay council and to some barangay folks. An ocular visitation was made to the six selected sampling sites. Altitude ranges from 1 to 20 are rank as low altitude (L), 21 to 40 as mid altitude (M), and 41 and above as high altitude (H).

Table 1. The six study sites in Palompon, Leyte. This data was acquired from the office of the Municipal Planning and Development Coordinator (MPDC) of the Palompon Local Government Unit.

Study Site No.	Name of Barangay	Distance from Poblacion (km)	Total Land Area (hectares)	Altitude (m)
#1	Rizal	4	320.51	30.54 (M)
#2	Lat-Osao	14	470.76	62.00 (H)
#3	Mazawalo	1	12.52	18.20 (L)
#4	Taberna	13	543.263	69.00 (H)
#5	San Isidro	1.5	161	8.00 (L)
#6	San Miguel	4.5	431.338	23.00 (M)

Sampling Method

Ten whole plant of *Lygodium* were randomly taken from each site and were brought to the laboratory. Ten leaves (which is free of disease or damage) per plant from shoots randomly selected from all sides of the plant were combined into one sample. Only one leaf was selected from each sample. There were 10 leaf samples from each site and 60 samples for the entire study sites. Ten leaves out of the 60 samples that shows unique characteristics from the rest of the samples were again selected to be used in the identification of species. Stem diameter and internode length were measured in each sample and were recorded in a matrix.

Identification of *Lygodium* species

Specimens of *Lygodium* collected was then identified as to the kind of species using the morphological characteristics of the leaves such as leaf type, venation, arrangements, margin, shapes, and presence of hair in shoots. Leaves have been the center of many evolutionary and developmental studies, because they are the dominant and most conspicuous organs of most plants including ferns [Vasco 2013]. Although typically envisioned as compound, the leaves of ferns actually display great morphological diversity, thus, it makes ferns a key lineage for comparative studies on how leaves and vascular plants evolved. Morphological characteristics were recorded in a matrix.

Morphological Variations

Quantitative morphological features, such as the diameter of the stem and length of the internode, of collected samples of *Lygodium* were also recorded as basis in determining the variations of *Lygodium* between taxa. The 2-way ANOVA was used in determining the relationship between altitude and stem diameter and internode length. There is no significant relationship between the altitude and the two variables. Data Matrix was constructed to record the data. A BioDiversity Professional software was used in order to determine the variability of the species. The variation of specie between taxa was shown in a form of phenogram. A phenogram facilitates in visualizing varied data and can improve the analysis and dissemination of these data [Wolfe et al. 2013]. Robinson et al. (1992) believed that the variety of uses of phenogram will become more apparent particularly in a more complex experimental designs that involves 3 or more simultaneous measurements.

IV. RESULTS AND DISCUSSION

Identification of *Lygodium* species

There were 3 identified species of *Lygodium* found in the sampling sites of Palompon, Leyte, namely; *Lygodium articulatum* (Fig.4A), *Lygodium circinnatum* (Fig.4B), and *Lygodium palmatum* (Fig.4C). The reference specimen as shown was the basis of identifying the species of *Lygodium* from the actual sample.

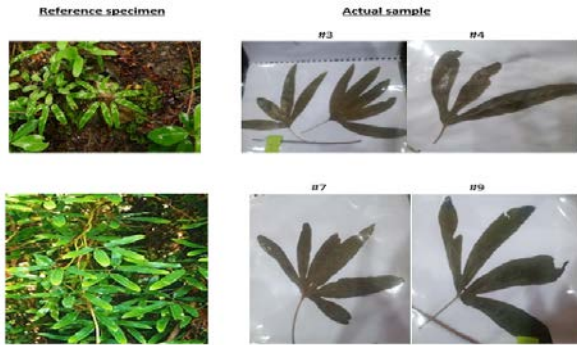


Figure 4A. *Lygodium articulatum*



Figure 4B. *Lygodium circinnatum*



Figure 4C. *Lygodium palmatum*

Table 2. The morphological characteristics of *Lygodium* in a matrix.

Species No.	Leaf Veins	Leaf Arrangement	Leaf Arrangement	Leaf Blade	Leaf Tip	Leaf Margin	Leaf Type	Shoot Hair
1	1	1	1	0	0	0	0	0
2	1	1	1	0	1	0	0	0
3	1	1	1	0	0	0	0	0
4	1	1	1	0	1	0	0	0
5	1	1	1	0	0	0	0	0
6	1	1	1	0	0	0	0	0
7	1	1	1	0	1	0	0	0
8	1	1	1	0	1	0	0	0
9	1	1	1	0	0	0	0	0
10	1	1	1	0	0	0	0	0
11	1	0	1	1	0	1	1	1
(outgroup)								
	0-parallel	0-pinnately	0-opposite	0-smoothed	0-pointed	0-entire	0-simple	0-present
	1-pinnate	compound	1-alternate	1-lobed	1-round	1-dentate	1-compound	1-absent
		1-palmately compound					ound	

The outgroup is a Pteridophyte and belongs to order Pteridopsida (Figure 5). This plant is also common in the study sites. A phenogram as shown in Figure 6 depicts the taxonomic relationship among samples of *Lygodium* based on the

morphological characteristics that were used to identify the *Lygodium* species present in Palompon, Leyte.



Figure 5. The outgroup: *Dennstaedti apunctilobula*.

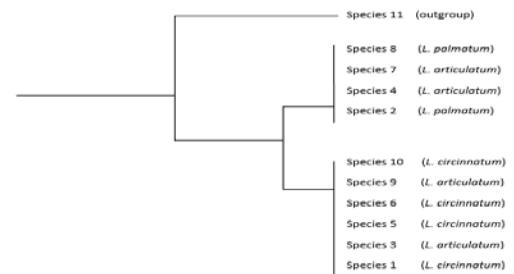


Figure 6. The phenogram of *Lygodium* species in Palompon, Leyte.

The groupings of the different species of *Lygodium* as the result of the Bio Diversity Professional almost matched with the identification of species based on referenced information except with species #7 and #4 which was expected to be with the same cluster with species #9 and #3. The first group matched with Figure 4C - the *Lygodium palmatum* which consisted of species #2 and #8 except #7 and #4 which belongs to another group, the *Lygodium articulatum*. The second group matched with Figure 4B – the *Lygodium circinnatum* which consisted of species #10, #6, #5, and #1 except #3 and #9 which must belong again to *Lygodium articulatum*. These specimens that were assigned as members of *Lygodium articulatum* (species #3, #4, #7, and #9) need more careful and extensive study. The leaves of each sample of these specimens were not uniform in the shape of their tip. In one leaf, we could see two different shapes; of the four lobes, two had rounded tips and the two had pointed tips; or of the 3 lobes, two had rounded tips and one has pointed tip. Based from the referenced specimen of these samples #3, #4, #7, and #9 as identified to be *Lygodium articulatum* was composed of such kind of leaf character that somehow possessed by both *Lygodium palmatum* and *Lygodium circinnatum*. Species #11 was a representative from another fern family.

The Relationship between the Altitude and the Stem Diameter of the Lygodium.

Table 3. The stem diameter of the 10 samples of *Lygodium* in each of the six sampling sites of the municipality of Palompon.

Sample No.	1) RIZAL (mm)	2) LAT-OSAN (mm)	3) MAZAWALO (mm)	4) TABERNA (mm)	5) SAN ISIDRO (mm)	6) SAN MIGUEL (mm)
1	2.70	3.50	2.60	1.40	2.70	3.50
2	1.90	4.40	3.50	2.80	2.70	2.00
3	2.30	4.00	3.50	2.50	2.20	2.80
4	2.30	4.40	4.00	1.00	2.00	2.00
5	2.00	4.00	2.30	2.50	3.00	2.70
6	2.00	3.50	2.20	1.70	2.80	3.20
7	3.00	2.60	2.40	1.10	2.90	3.20
8	2.70	3.00	3.70	1.40	2.70	2.80
9	2.80	3.50	3.90	2.90	2.90	2.30
10	2.30	3.30	3.90	1.30	2.90	3.20
Ave.	2.40	3.62	3.20	1.86	2.68	2.77
Elevation	30 m	62 m	18 m	69 m	8 m	23 m

The resulting table with computed values is shown below: $\alpha = 0.05$

Diameter	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	891.473	5	178.295	4.456	0.002
Within Groups	2160.826	54	40.015		
Total	3052.299	59			

Interpretation:

The result implies that there was a significant difference in the stem diameter of *Lygodium* (mm) between the six barangays of the Municipality of Palompon. There was no homogeneity of the samples among six barangays. It entails that the different stem diameter of *Lygodium* affects the site of six barangays.

The Relationship between the Altitude and Internode Length of the Lygodium

Table 4. The internode length of the 10 samples of *Lygodium* in each of the six sampling sites of the municipality of Palompon.

Sample No.	RIZAL (mm)	LAT-OSAN (mm)	MAZAWALO (mm)	TABERNA (mm)	SAN ISIDRO (mm)	SAN MIGUEL (mm)
1	15.20	24.00	18.00	18.30	26.10	2.40
2	15.30	23.50	30.50	26.10	25.60	7.00
3	10.30	29.00	18.50	10.50	20.30	13.40
4	16.30	27.70	11.80	14.00	6.90	15.00
5	23.30	26.00	28.30	14.60	25.00	26.00
6	33.00	34.80	22.60	7.10	30.60	25.70
7	22.00	18.90	28.90	14.40	27.30	19.30
8	23.00	25.50	21.80	11.00	29.50	16.50
9	27.70	25.80	28.30	21.20	20.00	20.60
10	23.90	23.00	29.10	12.70	21.20	23.10
Ave.	21.00	25.82	23.80	14.99	23.27	16.90
Elevation	30 m	62 m	18 m	69 m	8 m	23 m

The resulting table with computed values is shown below: $\alpha = 0.05$

Internode Length	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	18.791	5	3.758	11.559	0.000
Within Groups	17.557	54	0.325		
Total	36.348	59			

Interpretation:

The result implies that there was a significant difference in the internode length of *Lygodium* (mm) between the six barangays of the municipality of Palompon. There was no homogeneity of the samples among six barangays. It entails that the different internode length of *Lygodium* affects the site of six barangays namely; Rizal, Lat-osan, Mazawalo, Taberna, San Isidro, and San Miguel.

The Relationship between Altitude and the stem diameter and the Internode length of Lygodium based on phenogram.

The phenogram shows the relationships between the altitude and the two variables in the study (Figures 9 and 10) using the BioDiversity Professional.

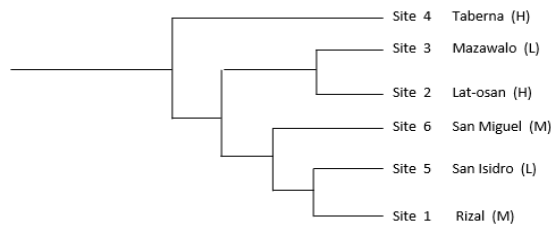


Figure 9. The Phenogram showing the relationship between altitude and the stem diameter of *Lygodium* in the six sampling sites of Palompon, Leyte.

Interpretation:

Site 4 (Taberna) had the highest altitude among the six groups. Site 3 (Mazawalo) and 2 (Lat-osan) were clustered group though they had opposite altitude as shown in Table 1. Site 1 (Rizal) and 5 (San Isidro) were clustered group yet they had opposite altitude. The phenogram shows that the stem diameter of *Lygodium* is not affected by altitude. The statistical analysis can be a support to the hypothesis that assumed that there is a significant difference between altitudes and stem diameter of *Lygodium*. There might some environmental factors that could affect stem diameter and internode length.

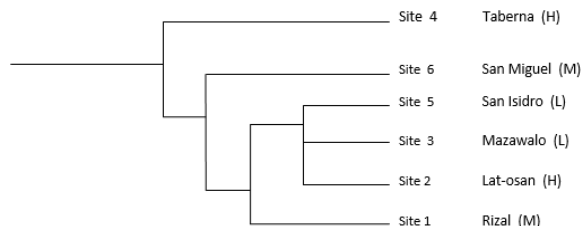


Figure 10. The Phenogram showing the relationship between altitude and the internode length of *Lygodium* in the six sampling sites of Palompon, Leyte.

Interpretation:

Site 5 (San Isidro) and 3 (Mazawalo) with lowest altitude were clustered group with site 2, the one with higher altitude. Site 1 shared the same characteristics with the group (the one composed with site 5, 3, and 2). Based on their place in the phenogram sites 5, 3, 2, and 1 could be probably the most diverse now in the present times among the sampling sites. The site which has the highest altitude (Site 1-Taberna) probably possess some characters in the stem especially with the stem diameter and with the internode length that could have been a character of the old ferns from the past.

V. CONCLUSION

Based on this study, there were two possible species found in Palompon, Leyte; the *Lygodium circinnatum* and *Lygodium palmatum*. One species, the *Lygodium articulatum* would need further investigation and a more extensive study in order to be proven that such species exist in Palompon, Leyte. The diameter of the stem and the Length of the internode of *Lygodium* depend on the location of each barangay but not on the altitude.

VI. RECOMMENDATION

Further research is required to study the diversity of *Lygodium* in Palompon, Leyte based on spores structure and formation. Study of distribution and abundance of *Lygodium* species in Palompon, Leyte is also recommended to see how likely it is that a species will occur in a specific location.

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