

The Diversity of Pteridaceae in Mount Ciremai National Park

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Abstract. The members of Pteridaceae are known varied in vegetative and generative structures. However, information about the generative characteristics is not well known, especially spore characters. The objective of this study is to learn the diversity of Pteridaceae reproductive structures in the Mount Ciremai National Park. Exploration was conducted in September in 2 locations: Mandirancang and Cigugur Sub-districts in 3 different ecosystems, i.e. homogeneous, heterogeneous and restoration areas. Observation of reproduction structure is done by observing the characteristic of sori position; shape and location of indusia; shape, color and spore ornamentation. Exploration in Mount Ciremai National Park found 11 species of Pteridaceae which are *A. capillus-veneris*, *A. hispidulum*, *A. lunulatum*, *C. tenuifolia*, *Cheilanthes* sp., *C. fraxinea*, *P. calomelanos*, *P. biaurita*, *P. ensiformis*, *P. longipinnula*, *P. venusta*. All observed spores had a trilete shape with a triradiate aperture. Among genera differ in the characteristics of the existence, shape and location of indusia and the surface and color of spores. *A. capillus-veneris* and *P. biaurita* are cosmopolitan species. Spores of each species may have different reproduction properties when they grow in different ecosystems. Thus, ecosystem differences affect the reproduction type of each ferns.

Keywords: *Pteridaceae*, *apogamous*, *cosmopolite*, *trilete spore*

1. Introduction

Pteridaceae is characterized by sporangia borne marginally and often covered by a marginal false-indusium, by trilete spores [1]. Morphologically, some members are characterized by a pair of basal pinna branched. This family has a considerable abundance of species in some ecosystems on a forest ground. Some species are scattered in various ecosystems and grow well in both dry and humid conditions. In term of ecology, the presence of fern is an indicator the quality of a forest habitat [2] since some cosmopolitan fern grow in areas with good environmental conditions, without any introduction or cultivation of these plants, but they will always exist in any region. The members of Pteridaceae are varied in vegetative and generative features. The vegetative characteristics have been used mostly for identification and classification among its genera and species, but information about their generative characteristic is less known especially their spore characteristics.

Pteridaceae species have trilete spores, but they are varied in spore characteristics among genera and species. The number of spores is one that determines the type of reproduction. The individual with a total of 32 spores per sporangium was classified into an apogamous type, while those with 64 spores



per sporangium were classified as a sexual type [3]. Previous studies showed that reproduction type of an individual fern is affected by environmental condition where they grow. Several environmental factors that affect the reproductive type of an individual fern were light, altitude and temperature [4]. Each individual fern has its own response to environmental factors affecting its reproductive type [5]. This paper reports the results of a study that compared the characteristics of reproductive structure among the Pteridaceae members grown in three different ecosystems in Mount Ciremai National Park.

2. Materials and methods

This research consisted of exploration and observation. The exploration was conducted in September 2016 in two locations: Mandirancang and Cigugur Sub-districts in 3 different ecosystems, i.e., homogeneous, heterogeneous and restoration areas. The reproduction structure was observed using an Olympus CX21 microscope and an OptiLab Viewer 2.1 camera. The observed characters of fern reproduction were sori position; shape and location of indusia; shape, color, and spore ornamentation. The reproduction type of fern was determined by counting spore number in a sporangium. An individual fern having 64 spores in its sporangium is classified as a sexual type, while an individual fern having 32 or 16 spore in its sporangium is classified as an apogamous type [6]. The calculation of the spore number in a sporangium was repeated 5-10 times.

3. Results

Pteridaceae found in Mount Ciremai National Park consisted of five genera (*Adiantum*, *Cheilanthes*, *Coniogramme*, *Pityrogramma*, and *Pteris*). In general, spores all members of this family are trilete and most members have a reflexed margin of lamina or false-indusium and exindusiate. Each genus has some distinct characters, which can be used to distinguish it from other genera. The distinct characters of each genus are frond feature; location and arrangement of sori; existence and variation of false-indusium. Within a genus, some species differ in some reproductive characters, which are spore color, the presence of equatorial flange, and the ornamentation of spore surfaces.

3.1. Identification Key and Description of Pteridaceae

3.1.1. *Pteridaceae*. Terrestrial. Rhizome erect are small creeping. Frond pinnate to tripinnate. Sori linear, near the margin or spread in abaxial lamina, covered by either false-indusium or exindusiate. Spore trilete with triradiate aperture (laesura).

Key to the genera

- | | |
|--|---------------------|
| 1a. Frond abaxial covered with a waxy powder..... | <i>Pityrogramma</i> |
| b. Frond abaxial not covered with a waxy powder..... | 2 |
| 2a. Sori covered by false-indusium | 3 |
| b. Sori not covered by indusium (exindusiate)..... | <i>Coniogramme</i> |
| 3a. Spore with equatorial flange..... | <i>Pteris</i> |
| b. Spore without equatorial flange..... | 5 |
| 4a. Trilete spore with tetrahedral shape..... | <i>Adiantum</i> |
| b. Trilete spora with globose shape..... | <i>Cheilanthes</i> |

3.1.2. *Adiantum*. Frond monomorph, pinnate to tripinnate. Pinna or pinnula have flabellate to cuneate segment. False-indusium is falter. Spore trilete, tetrahedral with less or without perispore, triradiate aperture.

Key to the species

- | | |
|---|----------------------------|
| 1a. Frond pinnate..... | <i>A. lunulatum</i> |
| b. Frond tripinnate | 2 |
| 2a. False-indusium has ornament spine-like..... | <i>A. hispidulum</i> |
| b. False-indusium has no spine-like..... | <i>A. capillus-veneris</i> |

- 3.1.3. *Cheilanthes*. Frond monomorph, bipinnate-tripinnate. Rachis glabrous, blackish purple to black.
 a. Sori continuous at marginal. Spore tetrahedral, rugose surface..... *C. tenuifolia*
 b. Sori falter. Spore globose, cristate surface..... *Cheilanthes sp*

3.1.4. *Coniogramme*.

Frond monomorph, bipinnate. Sometimes with variegated leaves. Sori exindusiate, yellow, linear on the vena. Spore pellucid or brownish, trilete, tetrahedral with triradiate aperture.....*C. fraxinea*

3.1.5. *Pityrogramma*.

Frond monomorph, tripinnate. Abaxial frond with a waxy white powder. Rachis glabrous, blackish purple. Sori exindusiate, spread in abaxial lamina. Spore trilete, tetrahedral with triradiate aperture, with an equatorial flange, surface reticulate..... *P. calomelanos*

3.1.6. *Pteris*. Frond pinnate to pinnate-pinnatifid with basal pair of pinna branched. Sori linear in marginal not reach apex leaves with reflexed margins of lamina or false-indusium or exindusiate. Spore trilete, with a prominent equatorial flange, distal surface papillate.

- 1a. Frond dimorph..... *P. ensiformis*
 b. Frond monomorph 2
 2a. Basal pinna branched. Sori with false-indusium..... 3
 b. Basal pinna not branched. Sori exindusiate..... *P. venusta*
 3a. Lobes 3/4 from pinnula..... *P. biaurita*
 b. Lobes 4/4 from pinnula..... *P. longipinnula*

3.2. *Reproduction Structure of Pteridaceae*.

The spores observation of each Pteridaceae found in the Mount Ciremai National Park in table 1 and figure 1.

Table 1. Species, Spores and Reproduction Types of Pteridaceae in Mount Ciremai National Park

Total genus	Species	Number of spore	Reproduction type	Seda Village			Palutungan line		
				He ¹	Ho ²	Res ³	He	Ho	Res
3	<i>Adiantum capillus-veneris</i> L.	64	Sexual	√	√	√			√
	<i>Adiantum hispidulum</i> Sw.	32	Apogamous						√
	<i>Adiantum lunulatum</i> Burm.	32	Apogamous		√				
2	<i>Cheilanthes tenuifolia</i> (Burm.) Sw.	28	Apogamous			√			
	<i>Cheilanthes sp.</i>	54	Sexual		√				
1	<i>Coniogramme fraxinea</i> Diels.	58	Apogamous	√			√		√
1	<i>Pityrogramma calomelanos</i> L.	64	Sexual	√				√	
4	<i>Pteris biaurita</i> L.	32	Apogamous	√	√	√			√
	<i>Pteris ensiformis</i> Burm.	64	Sexual		√	√			
	<i>Pteris longipinnula</i> Wall.	64	Sexual	√			√		√
	<i>Pteris venusta</i> Kunze.	64	Sexual		√				

¹ He = heterogeneous area

² Ho = homogenous area

³ Res = restoration area

4. Discussion

Adiantum capillus-veneris and *Pteris biaurita* found in all three observed areas, heterogenic forest, homogenous and restoration areas. It means both species are cosmopolitan species that are able to grow in many environments (table 1). This research found *Cheilanthes tenuifolia* with apogamous type with 28 spores in one sporangium. In contrast to previous research by Rosalin [6] found *C. tenuifolia* with sexual reproduction. This result indicated that individuals of the same species in different

locations allowed for differences in the number of spores. It caused by environmental factors affected to the growing place of an individual fern. [4] showed that the reproduction type of ferns can be affected by several environmental factors such as light, altitude and ambient temperature. Each fern has a different response to these environmental factors. But in this study individuals from a species observed from different locations or altitudes have no different in number of spores or reproduction types.

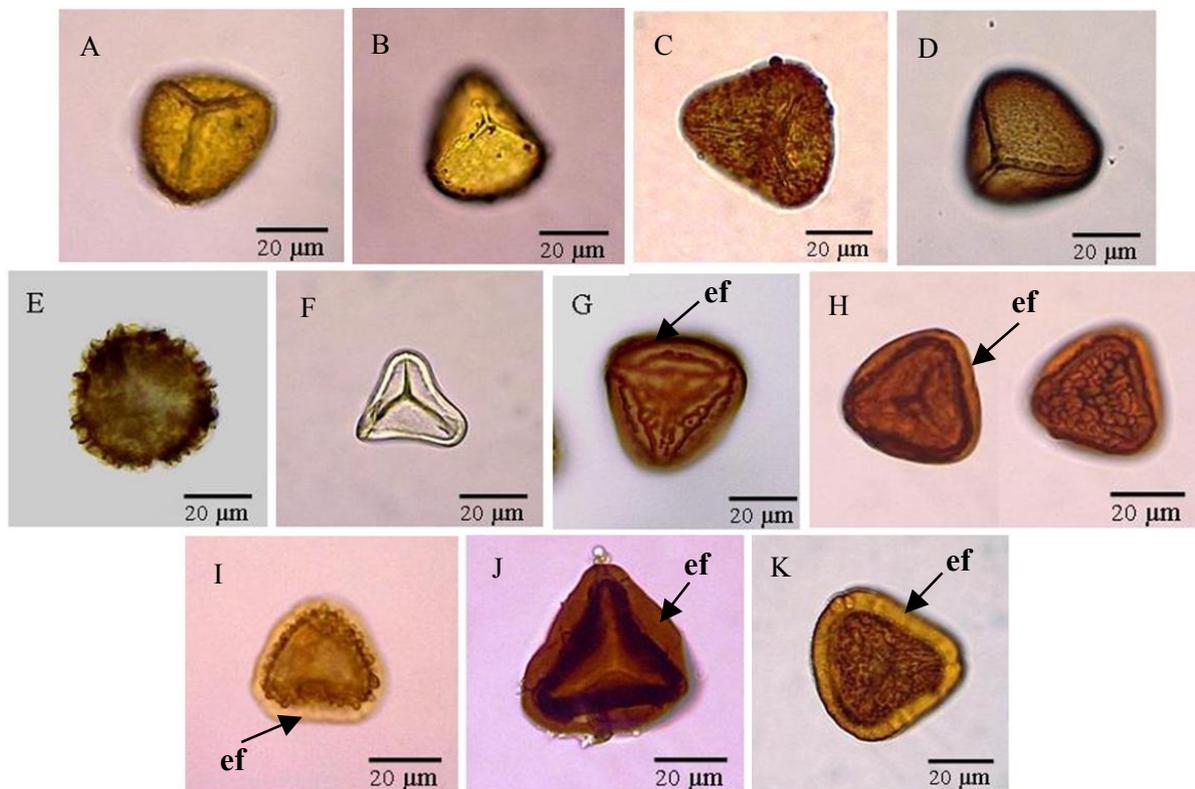


Figure 1. Spore structure (A) *A. capillus-veneris* L.; (B) *A. hispidulum* Sw.; (C) *A. lunulatum* Burm.; (D) *C. tenuifolia* (Burm.) Sw.; (E) *Cheilanthes* sp.; (F) *C. fraxinea* Diels.; (G) *P. calomelanos* L.; (H) *P. biaurita* L. with proximal and distal surface; (I) *P. ensiformis* Burm.; (J) *P. longipinnula* Wall.; (K) *P. venusta* Kunze; ef= equatorial flange.

The number of spores in one sporangium of an apogamous fern is 32 or less than 32 spores, but some researchers classified species with more than 32 spores or 64 spores with various spore shape and size as apogamous fern as reported by [7] in *P. vittata* and [5] on *P. exelsa*. In this study, we found an individual of *Coniogramme fraxinea*, which has approximately 58 spores with various spore sizes in a sporangium. Thus, we classified it as an apogamous fern. [8] stated that the ploidy level, the number of spores per sporangium, the size of the spores, the development of gametophyte, and the formation and morphology of young sporophytes have a close relationship with the type of reproduction. Various spore shape and sizes are possibly resulted in one sporangium because when some chromosomes paired and formed various chromosome pairing, univalent, bivalent or multivalent form, it will spread chromosome unevenly during meiosis, thus, the final result of meiosis is unbalanced chromosome number and abnormal spore shape [9,10].

5. Conclusion

All member of Pteridaceae have trilete spore with varied in shape, color, the presence of equatorial flange, and the ornamentation of spore surfaces. Six of 11 species have sexual reproduction type i.e.

Adiantum capillus-veneris, *Cheilanthes* sp., *Pityrogramma calomelanos*, *Pteris ensiformis*, *P. longipinnula* dan *P. venusta*, while the other five have apogamous type i.e. *Adiantum hispidulum*, *A. lunulatum*, *Cheilanthes tenuifolia*, *Coniogramme fraxinea* dan *Pteris biaurita*. All individual of observed species found in two or three different ecosystems in Mount Ciremai National Park have the same reproduction type. Thus, we concluded that environmental conditions could affect the reproductive type of an individual fern of a species.

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