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The Diversity of Pteridophyta at Mountain Telomoyo as Biology Learning Resources

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Abstract

The identification and utilization of pteridophyta diversity in the Telomoyo mountain area in learning activities has not been implemented. On the other hand, Biology as a science subject needs to be presented through scientific learning to encourage the development of students' science process skills. The type of learning resource by utilization is the right type to be used in scientific learning. These learning resources are found mainly in nature. Based on this, this study aims to identify the diversity of pteridophyta in Mount Telomoyo and to analyze their feasibility as a source of Biology learning at the high school. This study uses a descriptive exploratory method. The observation plot was determined to be 2 meters wide from the right and left side along the climbing route, using a purposive sampling technique. Analysis of learning resources using benchmarks by Djohar (1974). The results, there are 13 species of pteridophyta which can be classified into 12 genera, 10 families, 4 orders, and 2 divisions. Biology material that is appropriate for the application of learning resources is the Scope of Biology with a 75% suitability level. The results of the feasibility analysis of learning resources generally obtained a very feasible category (87%).

1. INTRODUCTION

Mount Telomoyo is a mountainous landscape located in Magelang and Semarang districts. Mount Telomoyo is located between Mount Merbabu, Mount Andong, Mount Sumbing, and Mount Ungaran. Mount Telomoyo is a type of volcano with a strato or cone shape (Putriutami, Harmoko, & Widada, 2014), with a relatively short height, which is 1894 masl. Until now, it has never been recorded that the mountain has experienced an eruption ((Indardi & Sahri, 2018).

Mount Telomyo has developed into a tourist destination for the community. Various factors support tourism activities in the region. According to the analysis conducted by Indardi & Sahri (2018), the development of the Mount Telomoyo tourism sector is supported by several elements,such as the comprehensiveness of regional infrastructure, socio-cultural readiness, the presence of local products and markets, the existence of a management institution, and the availability of human resources. The existence of these factors should be able to further develop the Mount Telomoyo area for other sectors, especially education, considering that there are many learning objects that can be found in the area.

Mount Telomoyo has a transitional climate from wet to dry (Syakirulalim, Sujadmiko, & Hadisusanto, 2016). This climate forms an environmental ecosystem that can support the development of various kinds of plants. Based on pre-research observations, we found various groups of plants around the Mount Telomoyo climbing route, one of which was pteridophyta.

Pteridophyta is a group of lower vascular plants (cryptogamae) such as bryophyta which can produce spores as a means of reproduction in their life cycle. Pteridophyta in everyday life is often referred to as "fern" (Fosberg, Sachet, & Oliver, 1982. Pteridophyta plants are generally characterized by circular shoots growing, on the underside of the leaves there are spots (sporangium) which sometimes grow regularly in rows and can also gather or spread (Wanma, 2016). In general, the pteridophyta structure is divided into 3 parts, namely the roots, stems and leaves (Kinho, 2009). According to Arini & Kinho (2012) pteridophyta can also be divided into two main parts, namely vegetative organs (roots, stems, rhizomes, and leaves) and generative organs (spores, sporangium, anteridium, and archegonium). Pteridophyta roots have a fibrous root system. The embryonic roots are divided into upper and lower poles. The upper pole develops into rhizomes and leaves, while the lower pole forms roots (Tjitrosoepomo, 1994). The growth of pteridophyta stems is not significant, but in "pteridophytes tree", the trunk grows like an areca nut (Sastrapradja et al. 1979). Pteridophyta stems are generally shaped like rhizomes that grow parallel to the ground. There are also pteridophyta stems in the form of poles, creeping or climbing. Pteridophyta leaves are commonly known as fronds (Wanma, 2016). Pteridophyta leaves consist of a leaf blade (lamina) and a stalk (stipe). The young leaves roll which is known as a coil. Adult pteridophyta leaves are fin-shaped (pinnate), each leaflet is called a fin (pinna) and the shaft where the fins are located is called rickets (rachis) (Loveless, 1999).

Pteridophyta can be found almost everywhere. The diversity of pteridophyta that is found in an area can be an indicator of the environmental conditions of the area (Kurniawati, Wisanti, & Rachmadiarti, 2016). In worldwide, the pteridophyta is estimated to reach 12,000 species (Stace, 1980). Meanwhile in Indonesia there are at least 1500 identified species of pteridophyta (Winter & Amroso, 2003). Pteridophyta plants can be found on the forest floor (terrestrial), as epiphytes, in places that are rich in sunlight, or in the sea (hygrophytes) (Postlethwait & Hopson, 2006). The abundance and distribution of pteridophyta plants is very high, especially in tropical rainy areas. Pteridophyta plants are also widely available in mountain forests (Ewusie, 1990 in Widhiastuti et al., 2006). One of the pteridophyta abundance in mountain forests can be found in the Telomoyo mountain area.

The identification of plant diversity in an area has an important role, both for the preservation of species and for meeting human needs. However, there are not any efforts to identify plant diversity in the Mount Telomoyo area. Research conducted by Syakirulalim, Sujadmiko, & Hadisusanto (2016) in the Mount Telomoyo area has just identified plants from the epiphytic moss group (briophyta). The research succeeded in identifying 13 species of epiphytic moss which were classified into 6 orders, 11 families and 2 classes. The research also succeeded in identifying species that could be utilized in the field of waste treatment. However, the data collection on other plant groups, especially pteridophyta, so far has not been carried out. Therefore, it is important to identify the diversity of pteridophyta in the Mount Telomoyo area, so that the results can be used for the development of other fields, such as research on the epiphytic moss.

Biology is a science-based subject. According to the structure of the national education curriculum, Biology subjects began to be taught separately at the high school level / equivalent. Science basically has 3 main elements, namely products, skills, and scientific attitudes. Science products in the form of facts and concepts, science skills in the form of scientific processes, and scientific attitudes are ethics in carrying out scientific processes. Biology learning needs to adopt these three main elements to produce students who have competence as scientists.

Through the standard process in the 2013 Curriculum, the achievement of the three main elements of science is emphasized even more. This can be seen in the aspects of learning achievement in the 2013 Curriculum which doesn't only include aspects of knowledge, but also aspects of skills and attitudes. However, conventional learning is carried out through a total conditioning model in students, where the teacher as the only center and source of learning only focuses on the achievement of elements of science products or aspects of knowledge, while other aspects of science, especially science process skills, cannot be facilitated.

Biology learning is more appropriate to be carried out using a scientific approach. The scientific approach is a learning design that focuses on the activeness of students in learning activities (student centered learning). The scientific approach applies the steps known as 5M (Zubaidah, 2014; Toy, Karwur, da Costa, Langkun, & Rondonuwu, 2018), namely observing, asking questions, gathering information, associating, and communicating. Through this approach, it can encourage students to obtain science products, as well as develop science process skills during the learning process. The scientific approach is rooted in constructivist theory. According to Razak, Hala, & Taiyeb (2016) that in the scientific approach students are given the opportunity to build concepts in their knowledge independently, familiarize students with formulating, dealing with and solving problems found (Razak, Hala, & Taiyeb, 2016). This is in accordance with the principles of constructive learning where knowledge is built by students independently (Kapludin, 2009).

The application of a scientific approach in Biology learning activities requires the right type of learning resource. Learning resources are generally divided into two types, namely learning resources by design and learning resources by utilization (Ali, 2007) (Sitepu, 2017). Learning resources by design are resources specifically designed or developed as components of an instructional system to provide focused and formal learning facilities. Learning resources by utilization are learning resources that are not specifically designed for learning purposes and their existence can be found, applied and utilized for learning purposes. Biology learning resources by design can be presented in the form of books, modules, internet sites which are examples of structured learning resources. Resources for learning biology by utilization can be found in the natural surroundings, for example forests, rice fields, rivers, fields, or landscapes / environments. According to Suratsih (2010) in learning biology, the natural environment around is a laboratory that has an important role because it has natural symptoms that can raise scientific problems. In conventional learning (direct instruction) which is more centered on educators, learning resources by design are the right choice, because in this learning design students only receive directly the structure and content of the material from the teacher. However, in a learning design with a scientific approach, where students are asked to construct their own subject matter, what is needed is a learning resource by utilization.

The source of learning by utilization in the biology subjects cannot necessarily be obtained through direct utilization of the natural surroundings. The appointment of a potential source of learning requires an analysis process first. According to Djohar (1974) there are several aspects that need to be considered so that an area is worthy of being a learning resource, namely clarity of potential, suitability of learning objectives, clarity of objectives, clarity of information that can be disclosed, clarity of exploration guidelines, and clarity of expected outcomes.

Based on the description above, the main problems found are 1) The efforts to identify pteridophyta plants in the Mount Telomoyo area that have not been carried out, 2) The potential for plant diversity on Mount Telomoyo that has not been utilized in the field of learning, and 3) Scientific learning in high school biology subjects requires learning resources by utilization that can be found in nature. Thus, it is necessary to conduct research in order to identify the diversity of pteridophyta in the Mount Telomoyo area and to analyze their feasibility as a learning resource in Biology learning at high school / equivalent level.

2. RESEARCH METHODS

The identification process of pteridophyta diversity was carried out using descriptive exploratory methods. This stage consists of 2 steps: 1) recording and documenting plants, and 2) determining plant species. Plant observation plots are determined in an area 2 meters wide from the edge of the climbing road, on the right and left side. The length of the observation plot is determined from the point of departure to the top of the mountain. Plant samples were selected using purposive sampling method, by selecting one plant from each species that had relatively more complete morphological characteristics. Morphological observations were focused on the leaves, stems, roots, and on their way of life. The determination of pteridophyta species was carried out by the method of comparing the morphological features of the identified pteridophyta plants. The instrument used in this stage was the pteridophyta plant observation sheet.

Feasibility analysis of Biology learning resources was carried out for the data related to the process and results of identification of pteridophyta diversity in Mount Telomoyo. This analysis was carried out in 2 steps: 1) determining the suitability of process data and pteridophyta identification results against the Basic Competencies of Biology in High School from the 2013 Curriculum, then 2) analyzing the feasibility of learning resources by referring to Djohar's (1974) criteria which consisted of 5 aspects, namely clarity. potential, suitability of learning objectives, clarity of objectives, clarity of information that can be disclosed, clarity of exploration guidelines, and clarity of expected outcomes. The process of analyzing learning resources involved 4 experts in the field of biology learning resources (expert judgment). The analytical instrument used is Likert scale questionnaire with 4 answer choices.

3. RESULT AND DISCUSSION

a. Pteridophyta diversity in Mount Telomoyo

Based on the results of the identification process that has been carried out along the hiking trail of Mount Telomoyo, 13 species of pteridophyta plants can be found. Each species has specific morphological characteristics. The results of the identification of pteridophyta plants on Mount Telomoyo are presented in Table 1.

Most of the pteridophyta plants on Mount Telomoyo are terrestrial plants that grow directly above the ground, between rocks and mountain cliffs. The genus of pteridophyta that grow terrestrial are blechnum, cyathea, davallia, gleichenia, goniophlebium, histiopteris, lindsaea, lycopodium, nephrolepis, pteris, and sphenomeris. Based on field observations, only 1 genus of pteridophyta plants were found growing attached to trees or as epiphytes, namely Drynaria sp. This species was found attached to the bark of pine trees, which are found in the area.

Some of the pteridophyta plants found could not be identified at the species level. The specimens were named only at the genus level, namely *Davallia* sp., *Drynaria* sp., *Goniophlebium* sp., *Nephrolepis* sp., *Pteris* sp., and *Sphenomeris* sp. Further analysis of some of these species needs to be done to reveal more detailed information regarding the level of taxon species.

Table 1. Identification Results of Pteridophyta Plants at Mount Telomoyo

Picture	Scientific Name	Way to Live
	*Blechnum* orientale	Terrstrial
	*Cyathea contaminans*	Terrstrial
	*Davallia* sp.	Terrstrial
	*Drynaria* sp.	Epifit
	*Gleichenia linearis*	Terrstrial
	*Goniophlebium* sp.	Terrstrial

	*Histiopteris incisa*	Terrstrial
	*Lindsaea lancea*	Terrstrial
	*Lycopodium complanatum*	Terrstrial
	*Lycopodium* cernuum	Terrstrial
	*Nephrolepis* sp.	Terrstrial

	*Pteris* sp.	Terrstrial
	*Sphenomeris* sp.	Terrstrial

(Source: Researcher Document, 2019)

Further analysis of the 13 pteridophyta species revealed information about the classification by the taxon level (Table 2). At the level of the taxon genus, the pteridophyta species found can be classified into 12 genera, namely Blechnum, Davallia, Drynaria, Goniophlebium, Histiopteris, Lindsaea, Sphenomeris, Nephrolepis, Pteris, Gleichenia, Cyathea, and Lycopodium. At the family taxon level, the pteridophyta species found can be classified into 10 families, namely Blechnaceae, Davalliaceae, Polypodiaceae, Dennstaedtiaceae, Lindsaeaceae, Nephrolepidaceae, Pteridaceae, Gleicheniaceae, Cyatheaceae, Lycopodiaceae. At the order taxon level, the pteridophyta species found can be classified into 4 orders, namely Polypodiales, Gleicheniales, Cyatheales, Lycopodiales. As for the class taxon level, the pteridophyta species found can be classified into 2 major groups, namely Polypodiopsida and Lycopodiopsida. The classification of pteridophyta plants is based on the 2016 Pteridophyte Phylogeny Group (PPG), which makes both classes the highest in the pteridophyta plant phylogeny group (Singh, 2019).

Table 2. Classification of Pteridophyta in Mount Telomoyo Based on The Taxon Level

Class	Ordo	Family	Genus	Species
Polypodiopsida	Polypodiales	Blechnaceae	Blechnum	*Blechnum orientale*
		Davalliaceae	Davallia	*Davallia* sp.
		Polypodiaceae	Drynaria	*Drynaria* sp.
			Goniophlebium	*Goniophlebium* sp
		Dennstaedtiaceae	Histiopteris	*Histiopteris incisa*
		Lindsaeaceae	Lindsaea	*Lindsaea lancea*
			Sphenomeris	*Sphenomeris* sp.
		Nephrolepidaceae	Nephrolepis	*Nephrolepis* sp.
		Pteridaceae	Pteris	*Pteris* sp.
	Gleicheniales	Gleicheniaceae	Gleichenia	*Gleichenia linearis*
	Cyatheales	Cyatheaceae	Cyathea	*Cyathea contaminans*
Lycopodiopsida	Lycopodiales	Lycopodiaceae	Lycopodium	*Lycopodium complanatum*
	Lycopodiales	Lycopodiaceae	Lycopodium	*Lycopodium* cernuum

(Source: Researcher Document, 2019)

Based on the Table 2, the identified members of the polypodiopsid class consist of 11 genera, while members of the lycopodiopsida class consist of only 1 genus member. Polypodiopsida is a part of the monilophyta phylum which has the main characteristic of its leaf structure in the form of megaphylls (Reece, 2010). Megaphyll leaves are leaves with a branching system of vessels. Lycopodiopsida is a part of the lycophyta phylum which has the main characteristic of its leaf structure in the form of microphyll (Reece, 2010). Microphyll leaves are leaves that have only one simple vessel structure located in the middle of the leaf.

Through a qualitative analysis process by determining which pteridophyta plants were mostly found, it was known that *Gleichenia linearis* was the dominant pteridophyta species on Mount Telomoyo. Previous research has also shown that this species dominates an area in the Sriwijaya Botanical Gardens, South Sumatra (Komalasari, O., Maryani, S., Juairiyah, O., & Novriadhy, D., 2019). *Gleichenia linearis* has various benefits, apart from being a drug it has also been studied in the field of chemistry, which has been shown to be able to absorb lead ions (Darus, F. M., Buyong, F., & Abdullah, S., 2004).

b. Feasibility of Pteridophyta Diversity as a Source of Biological Learning

1) Suitability of Identification Results with Basic Biological Competencies

The process of analyzing the feasibility of learning resources begins with determining the Basic Competencies of the 2013 Curriculum which are suitable for the application of the process and the results of identifying pteridophyta diversity. In this analysis, not all Basic Competencies were analyzed, only the selected 4 Basic Competencies had the relevant discussion scope. Based on the results of this analysis (Table 3), it is known that the process and results of identification of the diversity of pteridophyta in Mount Telomoyo are more suitable for achieving Basic Competence 3.1 & 4.1. 2013). This suitability is based on several things: 1) the process of implementing pteridophyta identification basically uses a scientific work flow that supports Basic Competence 4.1, and 2) there are several facts and concepts of biological problems that can be raised, including about biodiversity and biology as a science, 3) there is an opportunity to conduct studies at the level of individual organization, population, community, and ecosystem.

Table 3. The suitability of Pteridophyta Identification Results with the Basic Competencies of the 2013 Curriculum

Basic Competence		Suitability
Knowledge	**Skills**	
3.1 Describe the scope of biology (problems at various biological objects and levels of liife organization), through the application of scientific methods and work safety principles	4.1 Presenting the data resulting from the application of scientific methods on the problems at various biological objects and levels of life organization	75%
3.2 Analyzing various levels of biodiversity in Indonesia along with its threats and preservation	4.2 Presenting the observations results of various levels of biodiversity in Indonesia and proposals for their conservation efforts	60%
3.3 Describes the principles of living things classification in five kingdoms	4.3 Compile a cladogram based on the principles of living things classification	60%
3.8 Grouping plants into divisions based on general characteristics, and relating its role in life	4.8 Presenting reports of observations and phenetic and phylogenetic analysis of plants and its role in life	65%
3.3 Analyzing the relationship between cell structure in plant tissues and organ functions in plants	4.3 Presenting data from observations of tissue and organ structures in plants	65%

(Source: Researcher Document, 2019)

Table 4. Feasibility of Pteridophyta Identification Results as Biology Learning Resources

Aspects	Feasibility Percentage	Feasibility Category
Clarity of potential	93%	Very clear
Suitability with learning objectives	84%	Very suitable
Clarity of objectives	86%	Very clear
Clarity of disclosed information	85%	Very clear
Clarity of exploration guidelines	78%	Clear
Clarity of expected outcomes	92%	Clear
Average	**87%**	**Very feasible**

(Source: Researcher Document, 2019)

a) Clarity of potential

In this case, the potential referred to the opportunity identifying the pteridophyta diversity in Mount Telomoyo as a Biology learning resource. The clarity of potential aspect obtained a percentage of 93% with a very clear category. It is supported by the results of the previous analysis, that the identification results of the pteridophyta can have a 75% chance of being a Biology learning resource in the Scope of Biology material for 10th grade of high school students / equivalent.

b) Suitability with learning objectives

Learning objectives are derived from Basic Competencies in the curriculum. In this case, the learning objectives to be achieved are that students are able to explain the scope of biology and be able to carry out a scientific work. Studies on the scope of biology can be supported by the existence of 1) biological problems that arise, which is biodiversity and biology as a science (scientific method); 2) specific biological objects, which is pteridophyta plants (kingdom plantae), and 3) the level of life organization from the individual, population, community, to ecosystem levels. The study of scientific work can be supported by the identification process of pteridophyta plants that apply scientific stages. Some of these things make the aspect of suitability with learning objectives reach a percentage of 84% with very suitable categories.

c) Clarity of objectives

The clarity of the objectives is the existence of a clear boundary for the problem study. The limitation of the study in this case is the identification process of pteridophyta diversity using a scientific process and the results of its identification which reveal the profile of pteridophyta diversity in Mount Telomoyo. This aspect gets a percentage of 86% with very clear categories. This indicates that the problems studied do not overlap with other problems. At the learning level, if learning uses these learning resources students will have the opportunity to understand the faced problems clearly.

d) Clarity of disclosed information

In this case, the Information is about the aspects of knowledge that can be obtained through the use of these learning resources. The aspects of knowledge can be divided into 3 categories, which is factual, conceptual, and procedural knowledge (Karthwohl, 2002). The revealed factual knowledge is the existence of pteridophyta plants with their specific characteristics. The revealed conceptual knowledge includes individuals, populations, communities, terrestrial, epiphytes, levels of biodiversity, and classification. The procedural knowledge that can be obtained based on the identification of pteridophyta diversity in Mount Telomoyo is a scientific procedure. Some of these things make the feasibility aspect with learning objectives reach a percentage of 84% with very clear categories.

e) Clarity of exploration guidelines

The clarity of exploration guidelines referred to available carrying capacity at the site (Mount Telomoyo) to carry out exploration activities, in this case to identify pteridophyta diversity. The clarity aspect of the exploration guidelines got a percentage of 78%. This aspect has the smallest percentage compared to other aspects, with a category that is still feasible. Things that support this aspect include: a) adequate facilities and infrastructure for the Mount Telomoyo area for learning activities, with the availability of facilities, including an information center, easy transportation access, availability of electricity, networks and water, as well as locations close to settlements citizens; b) the duration of learning activities using these learning resources can be adjusted to the learning time of the related material at school, and c) the used sheet for the identification of the diversity of pterdiophyta on Mount Telomoyo can be adopted as an exploration guideline sheet in biology learning activities.

f) Clarity of expected outcomes

The aspect of outcomes clarity got a percentage of 92% with a very clear category. This aspect is related to the clarity of the learning outcomes obtained through the application of these learning resources. There are 3 domains of learning outcomes, such as the cognitive, psycho motor and affective domains. Cognitive domains that can be achieved are factual, conceptual, and procedural knowledge as described in point d (clarity of disclosed information). The psycho motor domain that can be achieved is the ability to identify using scientific methods basead on the procedure. The outcome of the affective domain that can be achieved is a scientific attitude accompanied by the ability to carry out the stages of the scientific method.

4. CONCLUSIONS AND RECOMMENDATIONS

The results of this study indicate that in Mount Telomoyo there are 13 species of pteridophyta plants. All of these species can be grouped into 12 genera, 10 families, 4 orders, and 2 classes. The way of life of the pterdiophyta plants on Mount Telomoyo can be divided into 2, namely terrestrial and epiphytic. Meanwhile, the dominant pteridophyta species in the area are *Gleichenia linearis*.

Biology material that is most suitable for the application of learning resources is the Scope of Biology (10^{th} grade of high school) with a 75% suitability level. The feasibility of the identification results of pteridophyta diversity as a biology learning resource for high school in general received a very feasible category (87%). The details of each aspect, which is the clarity of potential is in the very clear category (93%), the suitability of the learning objectives is in the very feasible category (84%), the clarity of the objectives is in the very clear category (86%), the clarity of disclosed information is in the very clear category (85%), the clarity of exploration guidelines is in the clear category (78%), and the clarity of the expected outcomes is in a very clear category (92%).

Recommendations based on the results of this study are: 1) the need to identify several genera of pteridophyta plants in Mount Telomoyo which species has not been known yet, 2) the need to identify other plant groups to obtain more complete vegetation diversity data, and 3) packaging Learning resources based on pteridophyta diversity on Mount Telomoyo become an instructional module that needs to be done to realize more efficient, scientifically oriented, and contextual learning.

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