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Potential Learning Sources for Biology on the Topic of Biodiversity for High School Student in Paliyan Wildlife Sanctuary, Gunung Kidul, Yogyakarta

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Abstract. Learning sources are all objects and their phenomena that can be used to gain experience in solving particular problems. In general, not many learning sources for biology in high school from the surrounding environment have been utilized for the learning process, especially on the topic of biodiversity. One area with potential as a learning source is the Paliyan Wildlife Sanctuary in Gunung Kidul. This study aims to identify the types of tree stratum vegetation that have the greatest role based on their importance value index, diversity index, links between measurable abiotic environmental factors and stand grouping patterns and potential learning sources for grade X high school biology on the topic of biodiversity. The research design employed was explorative and descriptive. The sample was drawn using the plotless point-centered quarter method. The parameters gauged comprise density, dominance, frequency, importance value index (IV), diversity index, and relationships between measurable abiotic conditions (soil temperature, air temperature, humidity, light intensity) and stand patterns using cluster analysis. The potential of learning sources for biology was studied descriptively. The results showed 15 species of tree stratum vegetation in Paliyan Wildlife Sanctuary. The species with the highest IV was *Tectona grandis* (159.56%). The average diversity index (H') ranged from 0.28 to 0.73. The abiotic environmental conditions related to standing patterns were air temperature, soil temperature, air humidity, and soil pH. As shown by the descriptive study method, the research results can be learning sources for biology in grade X of high school on the topic of biodiversity.

INTRODUCTION

The environment as a learning source for biology has not been widely used by teachers for the learning process. The environment is a contextual learning source that can provide a learning experience for students to gain more meaningful learning. Biology learning sources outside of school enable learners to explore nature and their surrounding environment, and thus directly experience real objects that exist therein [1][2][3]. Biology learning, especially on the topic of biodiversity, has not fully used the environment as a learning source. The learning partly remains restricted to textbooks and the internet. Meanwhile, one environment that has potential as a high school biology learning source is the area of a wildlife reserve.

A wildlife reserve is a nature reserve area characterized by the diversity and/or uniqueness of animal species whose habitats are developed for their survival. According to Article 17 paragraph 2 of Act of the Republic of Indonesia [4], wildlife reserve territories can be used for research and development, science, education, limited tourism, and other activities that support cultivation. The wildlife reserve of Gunung Kidul Regency in Yogyakarta is Paliyan Wildlife Sanctuary, which is situated across Paliyan District and Saptosari District. This area is protected for having various types of plants, including herbs, shrubs, and trees. The tree stratum vegetation in Paliyan Wildlife Sanctuary and its potential as a biology learning source have never been studied. Therefore, it is necessary to do research on the potential of local learning sources for high school biology.

METHOD

The type of research conducted was exploratory research, which explores natural phenomena that cause and influence the occurrence of something [5]. The research was conducted in Paliyan Wildlife Sanctuary, Gunung Kidul, Yogyakarta, particularly in the protection block.

The population for data collection in this study is the tree stratum within the Paliyan Wildlife Sanctuary grounds. The sample consists of the species of trees found at each sampling point.

The Paliyan Wildlife Sanctuary protection block has an area of 53.87 ha. For the research sample, 10% of the total area was taken, namely, 5 ha, divided into three study areas of 1.7 ha. In each study area, 10 transect lines were drawn, each with a length of 100 m and a width of 17 m.

The abiotic environmental parameters measured at each stand included humidity, air temperature, soil temperature, soil acidity (pH), and light intensity. The vegetation parameters measured were density, dominance, frequency, relative density, relative frequency, and importance value index (IV). According to[6][7], the applied equations are as follows wildlife Sanctuary.

$$\text{Mean distance (D)} = \frac{\text{total distance}}{4 \times \text{number of sampling points}}$$

$$\text{Absolute density (DT)} = \frac{\text{unit area}}{(D)^2}$$

$$\text{The density of each species (K)} = \frac{\text{total number of species}}{4 \times \text{number of sampling points}} \times DT$$

$$\text{Relative density (KR}_i) = \frac{\text{density of i}}{DT} \times 100\%$$

$$\text{Frequency (F)} = \frac{\text{number of species sampling point}}{\text{number of sampling points}}$$

$$\text{Relative frequency (FR)} = \frac{\text{frequency of a species}}{\text{frequency of all species}} \times 100\%$$

$$\text{Dominance (D)} = \text{mean basal area of species i} \times \text{density of i}$$

$$\text{Relative dominance (DR)} = \frac{\text{dominance of a species}}{\text{total dominance of all species}} \times 100\%$$

$$\text{Importance value index (IV)} = KR_i + FR_i + DR_i$$

The equation for the Shannon-Wiener diversity index [6] is:

$$\text{Diversity index (H')} = -\sum p_i \log p_i$$

Note:
$p_i = \frac{n_i}{N}$
= Shannon index
n_i = importance value of each species
N = total importance value

Based on the results of research conducted in the Paliyan Wildlife Sanctuary area, a study of its potential as a biology learning source on biodiversity for grade X of high school was conducted descriptively. The study of the potential for biology learning sources refers to the opinions of Djohar[8] [9].

RESULT AND DISCUSSION

Importance Value Index (IV)

The importance value indices of the tree stratum species found in Paliyan Wildlife Sanctuary are presented in Figure 1.
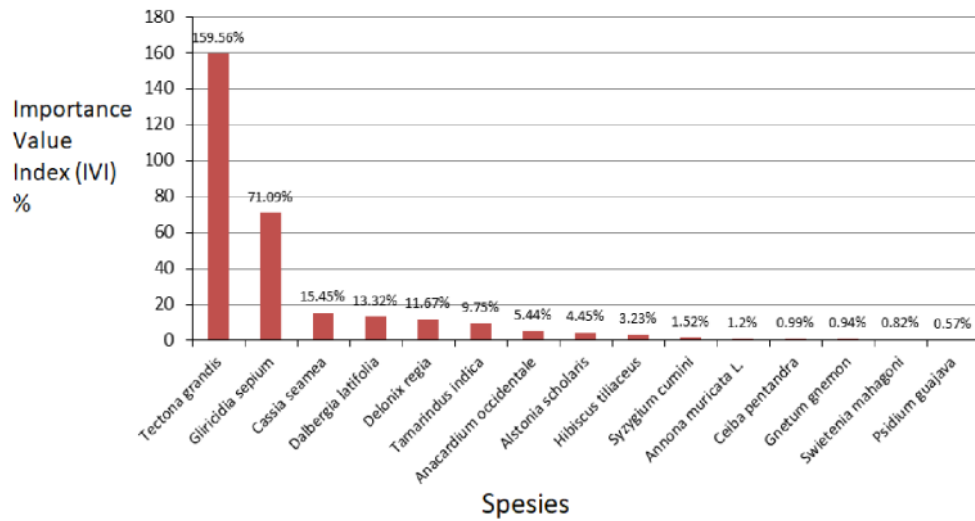
FIGURE 1. Importance Value Indices of the Vegetation

From this study performed in the protection block area of Paliyan Wildlife Sanctuary, 15 different species of tree stratum vegetation were found. The tree species that had the highest IV throughout the study areas was *Tectona grandis* (teak) with a mean of 159.56%, followed by *Gliricidia sepium* with an average of 71.09%, while the tree species with the lowest IV were *Swietenia mahagoni* with an average of 0.82% and *Psidium guajava* with a mean of 0.57%. The importance value index is an index that describes the important role of a vegetation species in its ecosystem [10]. When the IV of a plant species is high, its role in the ecosystem is also prominent.

The tree stratum species that had the highest IV of the 15 species was *Tectona grandis*, with a mean of 159.56%. The high IV of *Tectona grandis* in all study areas indicates that this species plays a major role as a habitat for animals around it and as a buffer for the ecosystem in Paliyan Wildlife Sanctuary. Abiotic environmental conditions influence the growth of tree stratum vegetation types. The results showed that the average soil pH was 8.0, the soil temperature was 31.73°C, the air temperature was 35.03°C, the humidity was 67.4%, and light intensity was 579.9 Lux. As stated by [11], the air temperature needed by teak plants ranges from 13 to 43°C, corroborating the results of this study where the average air temperature measured was 35.03°C, thus suitable for the growth of teak. According to [11] [12], *Tectona grandis* is a plant species resistant to drought as it has its way of facing drought, namely by dropping its leaves in the dry season and sprouting during the rainy season. Teak also has an extensive root system that can absorb water from the deepest soil layer, making it suitable to cultivate on dry land, according to the results of this study, where teak plants were found throughout the study areas.

Diversity Index

The diversity indices of the tree stratum vegetation species found in Paliyan Wildlife Sanctuary are presented in Figure 2.

The diversity index was average 0.57 for study area A, 0.36 for study area B, and 0.43 for study area C. Each diversity index in these three study areas was less than 1.00, indicating that the diversity of tree stratum species there was low. These low diversity index values owe to the *Tectona grandis* species that dominated the area. It aligns with the opinion of Shannon-Wiener [10] [7] that a diversity index value (H') of ≤1.00 entails a low level of diversity. The diversity index demonstrates the richness and evenness of vegetation species in an area [13][14][15]. The greater the H' value, the higher the diversity of the species. Species wealth is determined by the total number of species in a community[16].
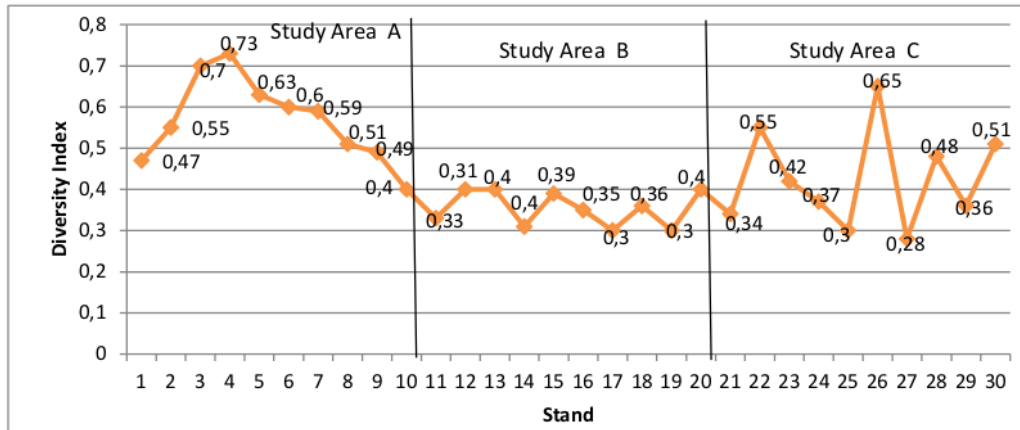
FIGURE 2. Diversity Indices of the Tree Stratum Vegetation

Measurable Abiotic Environmental Conditions

The abiotic environmental conditions measured in the Paliyan Wildlife Sanctuary area are provided in Tables 1 and 2 below.

TABLE 1. Measurement of abiotic environmental factors

Study Area	Temperature (℃)		Soil pH	Humidity (%)	Light Intensity (Lux)
	Air	Soil			
A	39.6	31.5	7.8	65.5	559.4
B	33.5	30.8	8.1	65.5	522.1
C	32	32.9	8.1	71.2	658.2
Total	105.1	95.2	24	202.2	1739.7
Mean	35.03	31.73	8	67.4	579.9

TABLE 2. Cluster Analysis ANOVA Test Results

	Mean Square	df	Mean Square	df	F	Sig.
Soil temperature	10.572	2	.291	27	36.331	.000
Air temperature	10.263	2	.314	27	32.699	.000
Humidity	4.538	2	.738	27	6.150	.006
Soil pH	5.596	2	.660	27	8.486	.001
Light intensity	2.442	2	.893	27	2.734	.083

Abiotic environmental conditions are very important for the growth of vegetation in nature [17][18][19][19] [20]. The abiotic environmental factors measured in the study areas in Paliyan Wildlife Sanctuary were air temperature at 32-39.6℃, soil temperature at 31.5-32.9℃, soil pH at 7.8-8.1, air humidity at 65.5-71.2%, the light intensity at 522.1-658.2 Lux. The cluster ANOVA resulted in a p-value of less than 0.05, indicating a significant link between abiotic environmental conditions and stand grouping patterns. Cluster analysis shows that abiotic environmental conditions comprising air temperature, soil temperature, soil pH, and air humidity were significantly related to the stand patterns of tree stratum species, but the light intensity was not.

Potential as Learning Source

Based on the results of this research on the diversity of tree stratum vegetation types in Paliyan Wildlife Sanctuary, its potential as a learning source on the topic of biodiversity for grade X high school biology was studied. The study was performed descriptively by referring to the opinion of Djohar [8], which stipulates that something can be used as a biology learning source if it meets the following criteria: (1) clear potential availability of the objects and issues raised, (2) conformity with learning objectives, (3) clarity of targets and purposes of the material, (4) clarity of information disclosed, (5) clarity of exploration guidelines, and (6) clarity of benefits to be gained.

In addition to adhering to Djohar's opinion [8] above, the descriptive study was also conducted in accordance with the opinion of [9], which states that something can be used as a learning source if it fulfills preconditions as follows: (1) availability of local sources, (2) availability of adequate funds, manpower, and facilities to provide the learning source, (3) factors that encompass the flexibility, practicality, and sustainability of the learning source for a relatively long period of time, and (4) cost-effectiveness for a relatively extensive-time period.

a. The clear potential availability of the objects and issues raised

The availability of objects from the results of this study was made clear by the 15 species of tree stratum vegetation found. The issue raised from this research is that Paliyan Wildlife Sanctuary has not been entirely utilized as a learning source on biodiversity for grade X high school students, specifically those in the vicinity of Paliyan Wildlife Sanctuary.

b. Conformity with learning objectives

The learning objectives refer to basic competency (3.2) of high school biology in the 2013 Curriculum, namely analyzing data from observations about various levels of biodiversity (genes, species, ecosystems) in Indonesia. Results of the study establish conformity with the learning objectives of biology on the topic of biodiversity at the ecosystem level.

c. Clarity of targets and purposes of the material

The targets of observations in this research are species of the tree stratum vegetation and measurable abiotic environmental conditions. These targets are designated for the material of biodiversity at the ecosystem level for grade X high school students.

d. Clarity of information disclosed.

The clarity of information uncovered in this study stems from the products of this research in the form of facts and concepts. The facts obtained from the research revealed 15 species of tree vegetation. The concept gained is the diversity of tree stratum vegetation types in Paliyan Wildlife Sanctuary.

e. Clarity of exploration guidelines

The clarity of the exploration guidelines in this study was revealed by the information about the diversity of tree species in Paliyan Wildlife Sanctuary which was gathered through a clear scientific work procedure including determination of the research location, research objects, observations to collect data, data analysis, discussion, and drawing conclusions.

f. Clarity of benefits to be gained

The clear benefits to be gained based on the study results are the expected improvement of students' abilities in the cognitive, affective, and psychomotor domains.

g. Availability of local sources

Paliyan Wildlife Sanctuary has a diversity of tree stratum vegetation types with the potential as a learning source for grade X high school biology, particularly on the topic of biodiversity.

h. Availability of adequate funds, manpower, and facilities to provide the learning source

The funds and manpower needed to provide a learning source in Paliyan Wildlife Sanctuary are relatively affordable. This is because the distance between Paliyan Wildlife Sanctuary and the high schools in the area is fairly close, thus saving costs and enabling relatively easy access to the necessary manpower and facilities.

i. Factors that encompass the flexibility, practicality, and sustainability of the learning source for a relatively long period of time

The area of Paliyan Wildlife Sanctuary has the flexibility and practicality for use as a learning source because it does not require any complicated procedure and equipment.

The area is protected so that the plants therein grow naturally without human intervention. Hence, in terms of sustainability, this area can be used as a learning source for a long time.

j. Cost effectiveness

A wildlife sanctuary is an area that, among others, can be used for research and education purposes so that carrying out activities within the area does not require large costs.

Based on the descriptions of the study results, it can be inferred that the diversity of tree stratum vegetation species in Paliyan Wildlife Sanctuary holds the potential as a learning source for grade X high school biology on the topic of biodiversity at the ecosystem level. According to the results, it is potential to be used as learning materials for first-grade senior high school. The aspects include object availability and the issues in question; suitability with the learning objectives; aims and purposes; information clarity; exploration guidelines; and the outcome [21][22][23][24] Most senior high school biology teachers (64.0%) say that natural resources available on land in East Kalimantan such as, mining products, plantations can be used as learning media for senior high school biology learning[25].

CONCLUSION

It can be concluded from the results of the discussion in this study that As many as 15 species of tree stratum vegetation were found in Paliyan Wildlife Sanctuary, and the species with the most prominent role by IV was Tectona grandis at 59.56%. The diversity index of tree vegetation in Paliyan Wildlife Sanctuary ranges from 0.28 to 0.73. The measurable abiotic environmental conditions significantly related to standing grouping patterns of tree stratum vegetation were air temperature, soil temperature, soil pH, and air humidity. Through the descriptive method used, the results of this research hold the potential as a learning source for grade X high school biology on the topic of biodiversity at the ecosystem level.

ACKNOWLEDGMENTS

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