



Pteridophyta in the Puncak Gaduang Area, Lubuk Basung, Agam Regency as a Learning Media for Plantae Materials

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Abstract

Ferns (Pteridophyta) are plants that can live easily in various habitats, both epiphytic, terrestrial and aquatic. The Puncak Gaduang Lubuk Basung area of Agam Regency is generally located in a lowland area, with the condition of the land having changed from hills to plantations and a place for taking soil for making bricks, but many types of ferns grow and develop in this area. The purpose of this study was to determine the types of ferns found in the Puncak Gaduang area, Lubuk Basung, Agam Regency and produce a valid herbarium. The method used in this study is a survey method with field observations first in taking ferns. The sampling technique is exploration, and the 4D model is used for the herbarium. The results of the study found 24 species of ferns consisting of 10 families, 4 orders and 2 classes. The validity test on the herbarium is included in the valid category. It can be concluded that the learning media in the form of a herbarium was suitable for use as a learning medium in schools.

Keywords: epiphytes; herbarium; plants; pteridophyta; terrestrial.

INTRODUCTION

Pteridophyta are plants that can be divided into three parts, namely roots, stems and leaves. Pteridophyta reproduce using spores which can be divided into two main parts, namely the vegetative organs which consist of roots, stems, rhizomes and leaves, the generative organs consist of spores, sporangium, and antheridium. arkogonium, the location of the sporangium of ferns is generally on the underside of the leaf and form brown or black clusters. These clusters of sporangia are known as the sorus to the leaf veins is a very important characteristic in classification Pteridophyta (Arini & Kinho, 2012; Yunita *et al.*, 2022; Prasani *et al.*, 2021). Pteridophyta can live in moist areas either on the ground, pines or attached (epiphytes) (Arini & Kinho, 2012; Apriyanti *et al.*, 2017; Dewanti *et al.*, 2020). Pteridophyta have an important role both ecologically, economically and educationally. Ecologically, ferns have a role as a soil buffer for watersheds, maintain soil moisture, form humus, and protect the soil from erosion. Its economic role is as an ornamental plant, as medicine and also for daily needs as vegetables (Arini & Kinho, 2012; Swastanti *et al.*, 2017; Leki *et al.*, 2022).

Herbarium is a collection of plant samples preserved for long-term study, usually in the form of dried and pressed plants mounted on paper. There are two kinds of herbarium. They are dried and wet herbarium. Herbarium specimens are useful as references for plant identification and for the determination of plant locations and ranges, abundance, habitat, and flowering and fruiting periods. In other words, herbarium represents the plant well. Thus, it can be used as learning media. Many research

concluded that when students were using herbarium as learning media, it will be more effective than those who did not use it (Dikrullah *et al.*, 2018; Dahlia & Janiarli, 2021; Mamu *et al.*, 2022). Even more, now the development of the herbarium is not only in the form of physical but in the form of digital media (Setiawan *et al.*, 2020; Widodo *et al.*, 2022). Of course, it makes easier to access anytime, anywhere, and by anyone.

Puncak Gaduang Lubuk Basung of Agam Regency has a beautiful and quite complete landscape. Lakes, seas, valleys, mountains, and forests lay out beautifully. In addition, the diversity of flora and fauna occupying the habitat (Pariwisata Sumut, 2020). However, this diversity of flora and fauna has not been properly recorded, especially for educational purposes. Flora and fauna in this area are still mostly used for tourism purposes. One of the diversity of flora that can be explored is Pteridophyta. The air is cool and tends to be humid, allowing for the habitat of Pteridophyta. Information on the diversity of Pteridophyta in Puncak Gaduang Lubuk Basung of Agam Regency will be more useful if it is recorded properly. Besides that, it can also be an added value for this area, namely being an educational tour. With the hope of attracting more tourists to visit.

Pteridophyta learning media can be used as education tool, Pteridophyta is also one of the materials in biology for class X SMA/MA Basic competence 3.8, namely grouping plants into divisions based on common characteristics and relating their roles in life. However, research by Leki *et al.* (2022) states that students' knowledge of Pteridophyta is still very minimal, this is because teachers tend to explain material in general and only use textbooks without additional media sources, so students do not understand Pteridophyta material. Based on this, other media sources are needed to support the learning process so that students can understand Pteridophyta material easily and effectively. So this study aims to identify Pteridophyta in the Puncak Gaduang Lubuk Basung area of Agam Regency, the results of which will be used as a biology learning media, namely the herbarium.

METHOD

This research was conducted in 2 stages, namely exploration and RnD for making learning media. RnD in education research is a process used to develop and validate educational products. The steps of this process are usually referred to as the R & D cycle, which consists of studying research findings pertinent to the product to be developed, developing the products based on these findings, field testing it in the setting where it will be used eventually, and revising it to correct the deficiencies found in the field-testing stage. Exploratory research was carried out using the cruising method where researchers walked starting from a predetermined point with a radius of 250 m towards the hill. Until the Pteridophyta were found, 3 samples were taken each to be identified. For those that could not be identified in the fields, then they were being made into a herbarium.

Pteridophyta identification using supporting books and journals. After all the samples were obtained from the field, they were then labeled and important data and information recorded for ferns whose species were already known. Then it is preserved by arranging it on newsprint one by one from the samples obtained. Then put it in a 50 kg plastic and sprinkle the spirit evenly, tie the plastic and tape it so that air does not come in and out. Then clamp the plastic containing the sample using cardboard / plywood then tie it again with raffia rope the samples were brought to the laboratory and then dried at room temperature. After drying, it is sewn onto mounting paper measuring 30 x 40 cm and equipped with a specimen identification label. Samples taken and used as a herbarium are only for different species. This is to minimize non-conservational sampling.

To determine the feasibility of the media being developed, trials were carried out to obtain input from experts and users. The media must be validated by material experts related to the results of the analysis of the structure and meaning of the text structure as teaching material. Furthermore, to media experts who can provide an assessment of the feasibility of the structure and components of media products. The validation results were adjusted and repaired to be tested as a learning medium. After making learning media, the media is tested by experts to find out whether the media is effective and

feasible to be used as learning media. The media was tested by 3 experts. The data obtained from the results of the expert validation questionnaire on the feasibility test of learning media uses the following formula:

$$\text{Validitas score} = \frac{\text{Total score obtained}}{\text{Total score maximum}} \times 100\%$$

RESULT AND DISCUSSION

Based on the results of research that has been carried out on Pteridophyta in the Puncak Gaduang area, Lubuk Basung, Agam Regency it was found 24 species consisting of 10 families, 4 orders and 2 classes. Pteridophyta obtained can be seen in Figure 1.

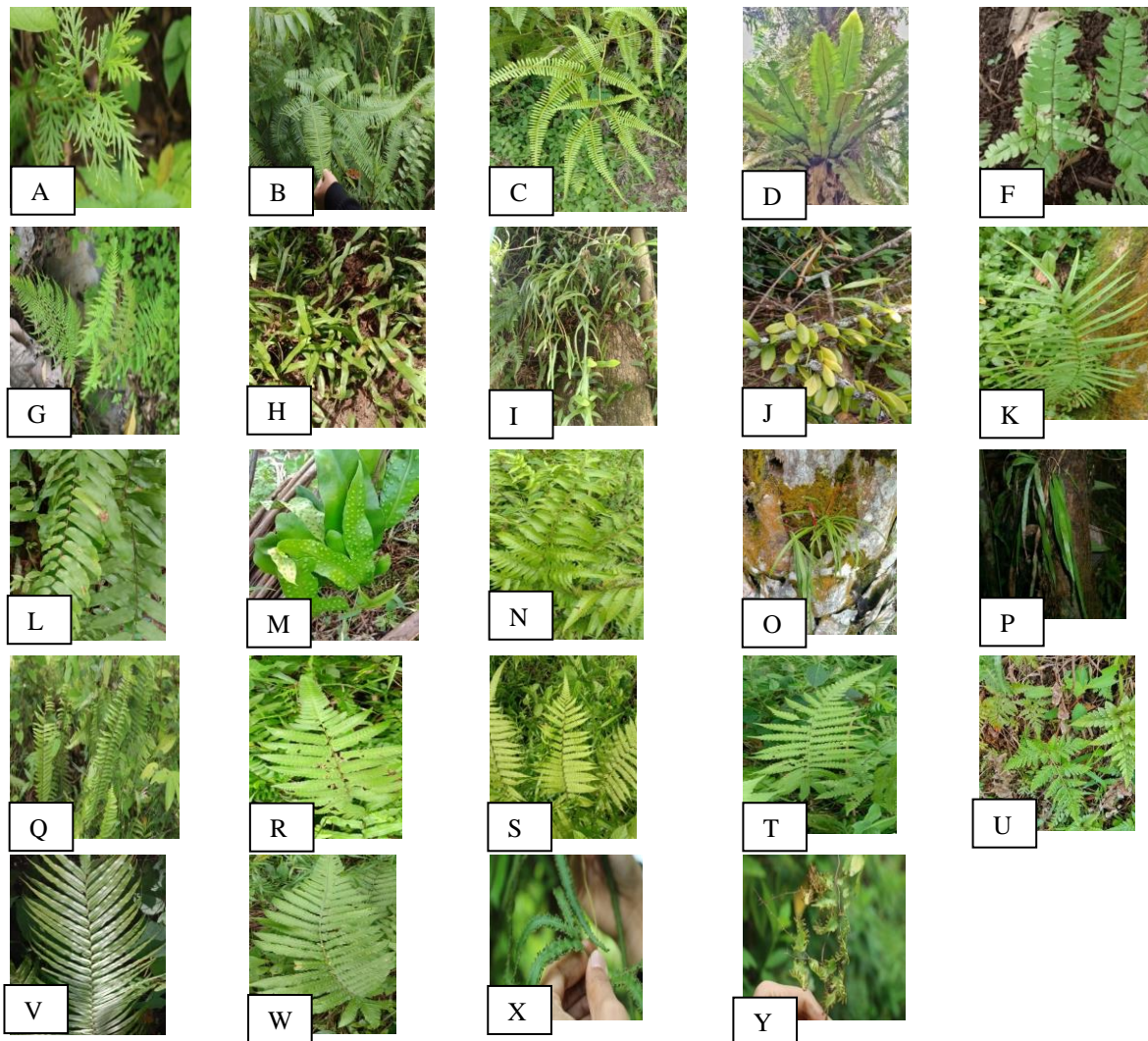


Figure 1. (A) *Selaginella willdenowii* (B) *Gleichenia linearis*(C) *Dicranopteris flexuosa* (D) *Asplenium nidus* (E) *Adiantum humile* (F) *Pityrogramma calomelanos* (G) *Pyrrosia lanceollata* (H) *Pyrrosia adnascens* (I) *Pyrrosia piloselloides* (J) *Pteris longifolia* (K) *Crypsinus taeniatus* (L) *Phymatosorus scolopendria* (M) *Diplazium esculentum* (N) *Vittaria lineata* (O) *Vittaria zosterifolia* (P) *Nephrolepis biserrata* (Q) *Christella dentata* (R) *Thelypteris palustris* (S) *Thelypteris simulata* (T) *Davallia denticulata* (U) *Blechnum serrulatum* (V) *Pleocnemia irregularis* (W) *Lygodium circinatum* (X) *Lygodium microphyllum*. (Source: personal documentation)

The first found is *Selaginella willdenowii*, *Selaginella willdenowii* has upright rhizome, scaly, branching irregularly. Leaf type macrophile, green in color, oval in shape, not too covering the surface of the stem, clustered at the end of the stem so that it appears to cover the stem, stem with smooth scales and erect. Sporangium is collected in the form of srobilus located at the end of the leaf. Live terrestrial in the open. The benefits of this fern are used for ornamental plants as a ground cover, the young leaves can be used as vegetables and also for herbal medicine and medicine for the Javanese people (Karim, 2022) (Wijayanto, 2014; Krisnawati *et al.*, 2021; Karim *et al.*, 2022). *Gleichenia linearis* has a short stalk, dichotomously branched, and slender. The leaves are pinnatus, the position of the leaves is opposite, the base of the pinna is united with the other pinna, the leaves are green. Sorus is located below the surface of the leaf, round in shape and life is terrestrial (Hasibuan *et al.*, 2016; Wahyuningsih *et al.*, 2019; Pradipta *et al.*, 2020). *Dicranopteris flexuosa* has leaves that are thin, short, the position of the leaves are opposite each other, and has supporting leaves. Stems are short, light brown in color, the rhizomes spread but do not form large groups (clusters). Spores are round and are under the surface of the leaves. Live terrestrial and This nail is useful for additional decoration, decoration, strong stems can be used as woven (da Silva *et al.*, 2011; Krisnawati *et al.*, 2021; Marpaung & Susandarini, 2021).

Asplenium nidus has short rounded rhizomes attached to the host, covered with brown scales. Spores are wavy and light brown located under the surface of the leaf (superficial) attached along the leaf veins. Macrophile leaves, very short petioles covered with hairs. fine hairs, pointed leaf tips, wavy and shiny edges, epiphytic living. The benefits of this plant are as house ornamental plants, treating swelling and bruising (Arini & Kinho, 2012; Pranita *et al.*, 2017; Raunsay *et al.*, 2020). *Adiantum humile* has a short creeping rhizome. Bipinate leaves, leaves arranged alternately slightly overlapping, leaf edges serrated. Petiole blackish brown, short. Sori are marginal, disjointed, located below the leaf surface, arranged at the edge of the leaf. Living terrestrial and can be used for decoration and decoration (Ayatusa'adah & Dewi, 2018; Marpaung & Susandarini, 2021; Andries *et al.*, 2022). *Pityrogramma calomelanos* has blackish brown rhizomes, erect, short, has stiff dark brown hairs. Spores spread under the leaf surface (superficial). Stalk round, black, upright, has a groove and the base is black. Bipinnatus leaves, pointed leaf base, pointed leaf tip, pinnate leaf bones. Living terrestrially in the open. The benefits of this plant as decorative ornaments and ornamental plants (Apriyanti *et al.*, 2017; Ayatusa'adah & Dewi, 2018; Yolla *et al.*, 2022).

Pyrrrosia lanceolata has fibrous roots and creeping stems. Spores are located under the surface of the leaf, scattered half the leaf. Pinnatus leaves, leaf edges flat, green rather thick, leaf surface smooth, sterile leaves oval. Epiphytic life. Can be used for decoration and additional decoration on flower arrangements (Sofiyanti & Novaliza, 2018; Hartini, 2020; Yolla *et al.*, 2022). *Pyrrrosia adnascens* has a rhizome that is round, slender and dark brown in color, scales are dark brown. The leaves are of different sizes, the leaf surface has fine hairs. The spores are brown and round in shape. They live in an epiphytic manner. Usually used for traditional medicine, for example to treat pain head by attaching the crushed leaves with cumin and shallots, can also treat dysentery (Lindasari *et al.*, 2015; Sianturi, 2020; Gilang *et al.*, 2022). *Pyrrrosia piloselloides* has a long creeping rhizome, light brown with tightly attached dark brown scales. Leaves are round, oval, flat edge, rather thick, glossy, leaf base is pointed, leaf tip is rounded. Sterile leaves are smaller in size than fertile leaves. Sorus located along the edge of the tip to just before the base of the leaf, reddish brown in color. Epiphytic life. Usually used for anti-inflammatory drugs, constipation, stomach ache, and canker sores (Yunita *et al.*, 2022)(Lindasari *et al.*, 2015; Sofiyanti & Novaliza, 2018; Yunita *et al.*, 2022).

Pteris longifolia has the shape of a pinnatus leaf, the size of the leaves varies, some are larger than the other leaves, thickened with a lanceolate leaf shape. The spores are arranged lengthwise below the lower edge of the leaf surface. Live terrestrial. Usually often used as an addition to floral arrangements (Hasibuan, 2016; Ayatusa'adah & Dewi, 2018; Atho *et al.*, 2020). *Crypsinus taeniatus* Compound leaves, elongated leaflets, flat edge, pointed base, rounded tip, pinnate repeat, same fertile and sterile leaves, thin texture. The color is dark green on the top of the leaves and light green on the bottom of the leaves. Sorus is near the veins, round, arises on the adaxial part of the leaves, and has fibrous roots. Lives as an epiphyte. The benefits of this fern are usually used as a wound medicine (Lindasari *et al.*, 2015; Hasibuan

et al., 2016; Sianturi, 2020). *Phymatosorus scolopendria* has a slender spherical rhizome, green in color, has dark brown scales. Single fronds, smooth surface, shared leaf edges, tapered tip and base of leaves. Stems are hard and sturdy, green, brownish and black. Sorus round, arranged in 2 irregular lines, slightly sinking brown. Terrestrial life. The benefits of this plant are believed to be able to cure ulcers, by mashing the ferns and then applying them to the boils (Listiyanti *et al.*, 2022)(Lindasari *et al.*, 2015; Sofiyanti & Harahap, 2019; Listiyanti *et al.*, 2022).

Diplazium esculentum has a short rhizome. The leaves are compound, the leaves are serrated, the tip is sharp, the base of the leaf is rounded, the leaf veins are pinnate, dark green in color. The young fronds are covered with light brown scales. Brown in color. The benefits of this type of fern can be consumed for vegetables (Wijayanto, 2014; Turot *et al.*, 2016; Listiyanti *et al.*, 2022). *Vittaria lineata* this type of fern is characterized by a single leaf that is shaped like a leaf of grass. The rhizome creeps rather long with a surface covered with scales that end like hair, dark brown. The upper surface of the leaf is glossy green. The edges of the leaves are slightly curved to the surface. the underside of the leaf, covering the collection of spores along the lower surface of the leaf. Epiphytic life and can be used for decoration (Arini & Kinho, 2012; Turot *et al.*, 2016; Hartini, 2020). *Vittaria zosterifolia* has a single leaf, flat edge, pointed leaf tip, pointed leaf base, leaf reinforcement is not clear. The shape of sterile leaves and fertile leaves is the same. There is hair on the rhizome. Life is epiphytic and can be used for decoration (Pranita *et al.*, 2017; Sofiyanti & Novaliza, 2018; Raunsay *et al.*, 2020). *Nephrolepis biserrata* has a short rhizome, stalk erect, round, blackish brown covered with fine brown scales. Ental pinnate, pointed leaf tips, arranged alternately. Sorus is greenish-white when young, brown when ripe, lies in a row under the leaf surface. Lives terrestrial. Can be used for ornamental plants (Apriyanti *et al.*, 2017; Dewanti, 2020; Gilang *et al.*, 2022). *Christella dentata* creeping roots, dark in color and branching. Stems are woody brown, spores are located under the leaf surface. Ental pinnatus, leaves are arranged alternately, leaf tips are pointed. Terrestrial life and these spikes can be used for traditional medicine, decoration.

Thelypteris palustris has an erect rhizome with black-brown scales. Ental pinnatus, leaf arrangement alternate, serrated edges. Stems are brownish green, white haired. Sorus is round brown in color. Life is terrestrial and can be used for decoration and additional decoration on floral arrangements (Sianturi, 2020; Yolla *et al.*, 2022; Yunita *et al.*, 2022). *Thelypteris simulata* has an upright rhizome. The stalk is green. The leaf surface is covered with white fine hairs, the leaf arrangement is alternate, the leaf tip is tapered (Sofiyanti & Harahap, 2019; Wahyuningsih *et al.*, 2019; Hartini, 2020). *Davallia denticulata* has round, long, scaly, brown rhizome, creeping. Leaves are stiff and strong, light green in color, triangular in shape, leaf edges are toothed, leaf surface is smooth and shiny. Stems are brown, shiny. Sorus is light brown. Epiphytes live in the shade The benefits of this fern plant are used as ornamental plants because of their attractive shape and can also be used as additional decorations on flower arrangements (Arini & Kinho, 2012; Sianturi, 2020; Leki *et al.*, 2022).

Blechnum serrulatum has rhizome in the form of scales. Spores are in the form of thick dark brown lines along the right and left sides of the leaf veins. The leaf stalks are round, brownish green. The leaves are bipinnatus, alternate leaves facing upwards, the leaflets are light green. Lives terrestrially above the soil surface. The benefits of this plant are as handicrafts, decorative ornaments and house ornamental plants (Turot *et al.*, 2016; Apriyanti *et al.*, 2017; Dewanti *et al.*, 2020). *Pleocnemia irregularis* has an erect rhizome, scaly blackish brown. Ental pinnatus, alternate leaf arrangement, leaf edges slit, leaf tip pointed, leaf base rounded. Stem is brownish green. Sorus is located below the leaf surface, brown in color. Terrestrial life and used for decoration (Wahyuningsih *et al.*, 2019; Atho *et al.*, 2020; Nursanti, 2020). *Lygodium circinatum* has a slender stature. The rhizome is creeping, green in color. The leaves are thin, strong and bright green in color. The leaves are getting narrower and sharper towards the end. The spores are located on the edges of the leaves, clustered and lined up. The old leaves are taken to make handicrafts, the leaves are also used to treat wounds in the Lumajang area. They live as epiphytes and are often found in open places (Arini & Kinho, 2012; Karim, 2017; Ayatus'adah & Dewi, 2018). *Lygodium microphyllum* rhizome twisted. Sterile leaves serrated, fertile leaves narrow or smaller than sterile leaves, leaf edges notched. Leaflets are triangular in shape, petioles are slender, brown in color. Sori emerge along the edge of the leaf. Life is terrestrial and can be used for decoration. Of the 24 species of ferns

found, 35% of ferns were epiphytic and 65% of ferns were found to live terrestrially (Apriyanti *et al.*, 2017; Andries *et al.*, 2022; Gilang *et al.*, 2022).

Pteridophyta found in the Puncak Gaduang Lubuk Basung area of Agam Regency are 24 species consisting of 10 families, 4 orders and 2 classes. The highest number of species was found in the family Polypodiaceae with 11 species, the family Aspleniaceae, Nephrolepidaceae, Davalliaceae, Blechnaceae, Dryopteridaceae with 1 species each, and the family Thelypteridaceae with 2 species. The families Lygodiaceae and Gleicheniaceae each found 2 species. Selaginellaceae family found 1 species. This indicates that the Puncak Gaduang Lubuk Basung area of Agam Regency is good for supporting the growth and development of ferns. The Polypodiaceae family is the most commonly found tribe. The high number of this tribe is thought to be due to fern species from the Polypodiaceae family, most of which are ferns that grow on soil, especially moist and shaded soil. The species whose habitat is terrestrial are more numerous than epiphytes, while the families Aspleniaceae, Nephrolepidaceae, Davalliaceae, Blechnaceae, Dryopteridaceae have 1 species each, and the family Thelypteridaceae are 2 species. The families Lygodiaceae and Gleicheniaceae each found 2 species. Selaginellaceae family found only 1 species. The Polypodiaceae family has a large number of species, almost 1000 species have been found and are scattered in the tropics and sub-tropics, most of them live epiphytes and are classified as modern ferns so that this species is included in a group that has adaptations that are well adapted. high enough and make it easy to distribute widely (Nurchayati, 2016; Dita *et al.*, 2018; Sofiyanti & Harahap, 2019).

Learning resources on Pteridophyta material are still very rare to find so that the results of an inventory of Pteridophyta in Puncak Gaduang Area are used as learning media in the form of herbarium so that they can be useful for education. This learning media can be used in biology subjects in class X high school, more precisely in KD 3.8 which discusses the division of Pteridophyta. The herbarium learning media that has been made are then revised by experts and the deficiencies of the learning media are corrected so that the media is appropriate and effective for use. The validity test on teaching media in the form of a herbarium was carried out by 3 validators. The results of the validity analysis can be seen in the following table 1.

Table 1. The results of the validity

No.	Aspect	Validator rating			Total Score Gain	Highest Score	Criteria Validity	Value
		V1	V2	V3				
1.	Contents	17	20	15	52	60	86,67%	Very Valid
2.	Appearance	16	20	17	53	60	88,33%	Very Valid
3.	User convenience	10	9	9	28	36	77,78%	Very Valid
4.	Ease of language to understand	10	12	9	31	36	86,11%	Very Valid
Total Average							338,89%	Very Valid
							84,72%	

The results of the validity test on the plantae herbarium content aspect, namely the validator stated that it was very valid with an average value (86.67%). This shows that the description of the Pteridophyta herbarium of Plantae material contained in the Plantae material herbarium is in accordance with the 2013 curriculum, namely in accordance with the demands of core competencies, basic competencies, indicators, and learning objectives to be achieved. Where teaching materials, good learning media, namely teaching materials and learning media are arranged according to the learning objectives to be achieved by students (Supriyono, 2018; Khoerunnisa *et al.*, 2019; Magdalena *et al.*, 2021). Learning media made based on data collection in their habitat (Pertwi & Saputri, 2020; Fatonah *et al.*, 2023; Mufida *et al.*, 2023) can directly provide valid data. Learning objectives are derived from KI and KD as well as achievement indicators that have been determined beforehand. The display aspect is very valid

with an average value (88.33%). This illustrates that the herbarium media that has been made have shown the morphology of ferns, the unique characteristics that appear in each specimen, the attractive color combinations of the herbarium cover and the combination of shapes and sizes of letters on the herbarium cover are harmonious.

The ease of use aspect is valid with an average value (77.78%). This states that the herbarium media made easier for users to understand ferns, easy to understand monographs, and the information presented in the herbarium media is easy to understand. In developing teaching materials and learning media that need to be considered are layout, image display, font size, spacing, and language suitability with good and correct Indonesian rules (Hasanah, 2012, Nurseto, 2012; Magdalena *et al.*, 2021). Aspects of the ease of language to understand that is very valid with an average value (86.11%). This indicates that the language used in the Pteridophyta herbarium material *Plantae* is in accordance with the Indonesian language rules, the use of punctuation marks is appropriate, the use of the herbarium is very interesting because it allows users to observe objects directly. The sentences used in teaching materials and learning media must be simple, effective and clear so that they are easily understood by students (Nurseto, 2012; Supriyono, 2018; Magdalena *et al.*, 2021). Based on the questionnaire of the validity of the *Plantae* material herbarium, the results were very valid (84.72%). This means that the Pteridophyta herbarium of *Plantae* material developed has fulfilled four aspects of validity, including the feasibility of content, appearance, ease of use, ease of language to understand so that this *Plantae* material herbarium can be used in the learning process. This learning media can ease distance learning and will give more added value by combining with problem based learning (Aryati, 2021; Utami *et al.*, 2021; Gultom *et al.*, 2022).

CONCLUSION

Based on the research results, 24 species were found belonging to 10 families, 4 orders, and 2 classes. The Polypodiaceae family is the most commonly found tribe. The high number of this tribe is thought to be due to fern species from the Polypodiaceae family, most of which are ferns that grow on soil, especially moist and shaded soil. This indicates that the Puncak Gaduang Lubuk Basung area of Agam Regency is good for supporting the growth and development of Pteridophyta. After the media feasibility test was carried out by experts, the learning media in the form of a herbarium was suitable for use as a learning medium in schools.

REFERENCES

- Apriyanti, N., Jaya Santri, D., & Madang, K. (2017). Identifikasi Tumbuhan Paku (Pteridophyta) dan Kekerabatannya di Kawasan Air Tejun Curup Tenang Bedegung Kecamatan Tanjung Agung Kabupaten Muara Enim. *Jurnal Pendidikan Biologi*, 5(November), 116.
- Arini, D. I. D., & Kinho, J. (2012). The pteridophyta diversity in Gunung Ambang Nature Reserve North Sulawesi. *Info BPK Manado*, 2(1), 17–40.
- Aryati, A. (2021). The Effectiveness of The Plant Tour Project Model PJJ 3 in One to Increase Statistical Literature Ability of High School Students on Plant Diversity. *Journal Of Biology Education Research (JBER)*, 2(2), 74–85. <https://doi.org/10.55215/jber.v2i2.4873>
- Ayatusa'adah, A., & Dewi, N. A. (2018). Inventarisasi Tumbuhan Paku (Pteridophyta) Di Kawasan Kampus Iain Palangka Raya Sebagai Alternatif Media Pembelajaran Materi Klasifikasi Tumbuhan. *Edu Sains: Jurnal Pendidikan Sains & Matematika*, 5(2), 50. <https://doi.org/10.23971/eds.v5i2.729>
- D. Mamu, H., Mardin, H., Bunga Pagalla, D., Mustaqimah, N., & Fajryani Usman, N. (2022). Introduction of Herbarium and Identification of Plants Based on School Environments in MTs. Negeri 2 Gorontalo Regency. *Journal of Applied Community Engagement*, 2(1), 40–48. <https://doi.org/10.52158/jace.v2i1.343>
- da Silva, V. S., Cândido, A. C. da S., Muller, C., Laura, V. A., Faccenda, O., Simionatto, E., Hess, S. C., & Peres, M. T. L. P. (2011). Phytotoxic potential of *Dicranopteris flexuosa* (Schrad.) Underw. (Gleicheniaceae). *Acta Botanica Brasilica*, 25(1), 95–104. <https://doi.org/10.1590/S0102-33062011000100012>

- Dahlia, & Janiarli, M. (2021). The Effectiveness of Herbarium as a Learning Medium on Compound Leaf Material for Students' Achievement in Biology. *Proceedings of the International Conference on Educational Sciences and Teacher Profession (ICETeP 2020)*, 532(532), 114–118. <https://doi.org/10.2991/assehr.k.210227.019>
- Dikrullah, D., Rapi, M., & Jamilah, J. (2018). Pengembangan Herbarium Book Sebagai Media Pembelajaran Biologi Pada Mata Kuliah Struktur Tumbuhan Tinggi. *Jurnal Biotek*, 6(1), 15. <https://doi.org/10.24252/jb.v6i1.4426>
- Fatonah, C. N., Ningtias, R. A., Pertiwi, M. P., & Rostikawati, R. T. (2023). *Keanekaragaman Spesies Bivalvia dan Gastropoda di Pantai Tanjung Rising Kepulauan Bangka Belitung*. 24(1), 57–64.
- Gultom, A. S., Retnowati, R., & Yani, I. (2022). *Journal of Biology Education Research (JBER) Development of Science Literacy-based E-Booklet to Improving Students ' Critical Thinking Ability on Immune System Materials*. 3(1), 23–31.
- Hartini, S. (2020). Keanekaragaman Jenis Tumbuhan Paku (Pteridophyta) Di Kawasan Hutan Tumbang Manggu, Kecamatan Sanaman Mantikei, Kabupaten Katingan, Kalimantan Tengah. *Ekologia*, 20(1), 1–13. <https://doi.org/10.33751/ekologia.v20i1.1978>
- Hasanah, U. (2012). Upaya meningkatkan pemahaman konsep cahaya melalui pemanfaatan media pembelajaran benda optik di lingkungan sekitar pada siswa kelas VIII D SMP Negeri 2 Temon tahun pelajaran 2010/2011. *Jurnal Ilmiah Guru Caraka Olah Pikir Edukatif*, 16(01), 7–18.
- Ja, M. (2022). *A Photographic Atlas of Nglanggeran Plant Herbarium as a Plant Taxonomy Learning Source*. 871–874.
- Leki, P. T., Makaborang, Y., & Ndjoeroemana, Y. (2022). Keanekaragaman Tumbuhan Paku (Pteridophyta) Di Daerah Aliran Sungai Pepuwatu Desa Prai Paha Kabupaten Sumba Timur Sebagai Sumber Belajar Biologi. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, 13(1), 42. <https://doi.org/10.24127/bioedukasi.v13i1.5304>
- Lindasari, W. F., Linda, R., & Lovadi, I. (2015). Jenis-Jenis Paku Epifit di Hutan Desa Beginjan Kecamatan Tayan Hilir Kabupaten Sanggau. *Protobiont*, 4(3), 65–73.
- Listiyanti., R, Indriyanti., S, & Ilmiyah., N. (2022). Karakterisasi Morfologi Jenis-Jenis Paku Empirit pada Tanaman Kelapa Sawit di Desa Tegalrejo. *Al Kawnu: Science and Local Wisdom Journal*, 02(01), 99–106. <https://doi.org/10.18592/alkawnu.v2i1.7281>
- Mufida, I., Pertiwi, M. P., & Rostikawati, R. T. (2023). Diversity of Echinoderms in Drini Beach Gunung Kidul, Yogyakarta. *Jurnal ILMU DASAR*, 24(1), 19. <https://doi.org/10.19184/jid.v24i1.30097>
- Novalia, I., Utami, P., Rostikawati, R. T., & Lathifah, S. S. (2021). *Journal of Biology Education Research (JBER)*. 2(1), 14–20.
- Nurchayati, N. (2016). Identifikasi profil karakteristik morfologi spora dan prothallium tumbuhan paku familia polypodiaceae. *Jurnal Bioedukasi*, 14(2), 25–30.
- Nurseto, T. (2012). Membuat Media Pembelajaran yang Menarik. *Jurnal Ekonomi Dan Pendidikan*, 8(1), 19–35. <https://doi.org/10.21831/jep.v8i1.706>
- Pranita, H. S., Mahanal, S., & Sapta Sari, M. (2017). Karakteristik Spora Tumbuhan Paku Asplenium Kawasan Hutan Raya R. Soerjo. *Jurnal Pendidikan : Teori, Penelitian, Dan Pengembangan*, 2(4), 454–458.
- Pertiwi, M.P. & Saputri, D. D. (2020). Golden apple snail (*Pomacea canaliculata*) as an alternative protein source in Pasupati catfish (*Pangasius sp.*) fish feed. *Nusantara Bioscience*, 12(2), 162–167. <https://doi.org/10.13057/nusbiosci/n120212>
- Setiawan, E., Darnaedi, D., Rachman, I., Triono, T., & Webb, C. O. (2020). The Digital Herbarium: Solutions for Data Collection and Identification of Indonesian Plant Diversity. *Biogenesis: Jurnal Ilmiah Biologi*, 8(2), 203. <https://doi.org/10.24252/bio.v8i2.15697>
- Sianturi, A. S. R. (2020). The Phenetic Relationship of Ferns (Polypodiaceae) at the Ascent of Cemoro Kandang, Mount Lawu. *Jurnal Riset Biologi Dan Aplikasinya*, 2(2), 64. <https://doi.org/10.26740/jrba.v2n2.p64-69>
- Sofiyanti, N., & Harahap, P. H. (2019). Inventarisasi Dan Kajian Palinologi Jenis-Jenis Tumbuhan Paku (Pteridofita) Epifit Di Kawasan Universitas Riau, Provinsi Riau. *Jurnal Biologi Tropis*, 19(2), 214–

220. <https://doi.org/10.29303/jbt.v19i2.1266>
- Supriyono. (2018). Pentingnya Media Pembelajaran Untuk Meningkatkan Minat Belajar Siswa. *Pendidikan Dasar, II*, 43–48.
- Turot, M., Polii, B., & Hengki D, W. (2016). Potensi Pemanfatan Tumbuhan Paku Diplazium Esculentum Swartz (Studi Kasus) Di Kampung Ayawasi , Distrik Aifat Utara , Kabupaten Margaretha Turot Bobby Polii This study aims to analyze : (1) productivity ; And (2) some ecological aspects of nail plan. *Agri-SosioEkonomi Unsrat, 12*(3), 1–10.
- Wahyuningsih, Triyanti, M., & Sepriyaningsih. (2019). Inventarisasi Tumbuhan Paku (Pteridophyta) Di Perkebunan Pt Bina Sains Cemerlang Kabupaten Musi Rawas. *Jurnal Biosilampari : Jurnal Biologi, 2*(1), 29–35. <https://doi.org/10.31540/biosilampari.v2i1.815>
- Wijayanto, A. (2014). Keanekaragaman Dan Penyebaran Selaginella Spp. Di Indonesia Dari Tahun 1998-2014. *El-Hayah, 5*(1), 31. <https://doi.org/10.18860/elha.v5i1.3038>
- Yunita, I., Nurma, N., Ibrahim, I., & Andalia, N. (2022). Identifikasi Jenis-Jenis Tumbuhan Paku (Pteridophyta) Yang Tumbuh Di Desa Uning Pune Kecamatan Putri Betung Kabupaten Gayo Lues. *Jurnal Biology Education, 9*(1), 52–68. <https://doi.org/10.32672/jbe.v9i1.4519>