JPPIPA 11(7) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Comparative Morpho-anatomy of Two *Myriophyllum* Species (Haloragaceae) in West Lombok

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Received: February 10, 2025
Revised: June 05, 2025
Accepted: July 25, 2025
Published: July 31, 2025

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DOI: 10.29303/jppipa.v11i7.10636

Abstract: *Myriophyllum aquaticum* and *M. verticillatum* are macrophyte herbs that can grow in dry shallow waters. These plants are resistant to variations in water levels. These plants can also grow at higher water levels and, in shallow wetland habitats, slow-flowing rivers, reservoirs or irrigation channels, lake edges, ponds, swamps. This study aims to analyze the differences in morphology and anatomy of two *Myriophyllum* species, as well as to determine the conditions of the plant community structure and the ecological conditions of the plants. The results showed that the comparison of *M. aquaticum* and *M. verticillatum* plants has different characteristics in the roots, stems, leaf stalks, leaf blades, and glands on the leaves. The paradermal part of the *M. aquaticum* leaf blade has an actinocyte stomata type, while *M. verticillatum* has a parasitic type. This study also found that *M. aquaticum* is more dominant than *M. verticillatum*. The diversity of *M. aquaticum* and *M. verticillatum* is classified as low, the evenness of M. *aquaticum* is classified as moderate while *M. verticillatum* is classified as low. Based on Simpson's Dominance Index, *M. aquaticum* and *M. verticillatum* showed that both were stable in the community.

Keywords: Haloragaceae; Morpho-anatomy; *Myriophyllum aquaticum*; *Myriophyllum verticillatum*; West Lombok

Introduction

Myriophyllum is an aquatic plant originating from South America. This plant was introduced to North America as an aquarium plant and aquatic plant (Best Management Practices For "Parrot's Feather," 2021). In Indonesia, *M. aquaticum* found in Java, Papua, Sulawesi and Sumatra as an introduced plant (Powo, 2024). It was discovered and identified as a species that experienced naturalization, namely the process of a non-native species spreading into nature in various aquatic habitats. This plant is a genus that has approximately 68 aquatic species. This genera spread throughout the world (except Antartica), with centers of diversity in Australia 42 species (37 endemic species), North America 14 species (7 endemic species) and Asia 16 species (8 endemic species) (Arshid et al., 2011).

M. aquaticum are submerged to emergent plants that occupy different aquatic habitats. This aquatic plant has slender branches with sturdy, blue-green stems, mostly free-rooted below and floating. The submerged shoots reach the surface of the water, their growth changes and begins to propagate along the water surface. Broad branches develop from the nodes followed by vertical growth of the emerging stems. Heterophylla leaves are emergent and submerged, numerous, feather-like in appearance and greyish-green in color, pinnate and arranged in whorls of 4 to 6 segments around the stem. Emerging leaves protrude up to 25 cm from the water surface, are 2-4.5 cm long and have 6-18 splits per leaf, fewer splits and greener than submerged leaves. Submerged leaves are 1.5-3.0 cm long with 20-30 splits per leaf (Alfasane et al., 2019).

How to Cite:
Wulandari, N., Efremov, A., Muspiah, A., & Mulyaningsih, T. (2025). Comparative Morpho-anatomy of Two Myriophyllum Species (Haloragaceae) in West Lombok. *Jurnal Penelitian Pendidikan IPA*, *11*(7), 672–684. https://doi.org/10.29303/jppipa.v11i7.10636

M. verticillatum is an aquatic plant from the Haloragaceae family that grows in freshwater such as lakes, rivers, swamps, and ponds with calm currents (Crow & Hellquist, 2023). The parts of the plant that are above water are light green to shimmering and dense with small pectinate or feather-shaped leaves arranged in whorls of 5 to 6 per node, while the parts of the plant that are submerged are much sparser, with leaves that are longer and more stringy around the stem which turns reddish brown deeper underwater. Changes in position or water level, vegetation is able to adapt and change rapidly, in experimental conditions, parts of the stem were observed to change from an emergent form to a submerged form "within days" after the water level rose. The majority of the plant biomass appears to be above water, but the stems can extend down to 2 meters, where the rhizomin the sediment with thin roots (Becker & Wong, 2023).

The plant has a long, flexible stem, with leaves arranged verticillate, in the form of fine filaments that resemble feathers. The flowers are small, yellowish-green in color, and appear on stems that can rise to the surface of the water, while the fruit is in the form of a small capsule containing seeds (Moody & Les, 2007). Reproduction occurs vegetatively through stem fragmentation or generative through seeds. Ecologically, this species plays a role in providing habitat for aquatic organisms and absorbing excess nutrients in the waters. However, its rapid growth can lead to invasive properties, inhibit water flow, as well as lower dissolved oxygen levels (Nezbrytska et al., 2022).

This plant is one of the world's most troublesome invasive aquatic weeds. Although current management practices may inhibit its expansion, it also impacts not only the quality of water but habitat deterioration (Kumwimba et al., 2020). The plant have displayed great potential as a means of coping with such pollution. Therefore, it is crucial to understand the transport pathways of PTEs across sediment and organisms as well as their accumulation mechanisms in the presence of submerged plants and their biofilms (Geng et al., 2019).

However, although *M. aquaticum* has great potential as a source of active ingredients, invasive species can grow aggressively and disrupt the balance of aquatic ecosystems, including reducing native biodiversity, clogging waterways, as well as increasing the risk of eutrophication. In addition, there have not been many studies that comprehensively explore the mechanisms of morpho-anatomical adaptation and chemical content of these plants under various environmental conditions. The purpose of this study is to analyze the morphological and anatomical differences of *M. aquaticum*, as well as to know the condition of the plant community structure and ecological conditions of the plant, this research is expected to contribute to the management of this invasive species while utilizing its potential in a sustainable manner.

Method

The flow in this diagram shows the stages of research on the Comparative Morpho-anatomy of Two Myriphyllum Species (Haloragaceae) in West Lombok (Figure 1).

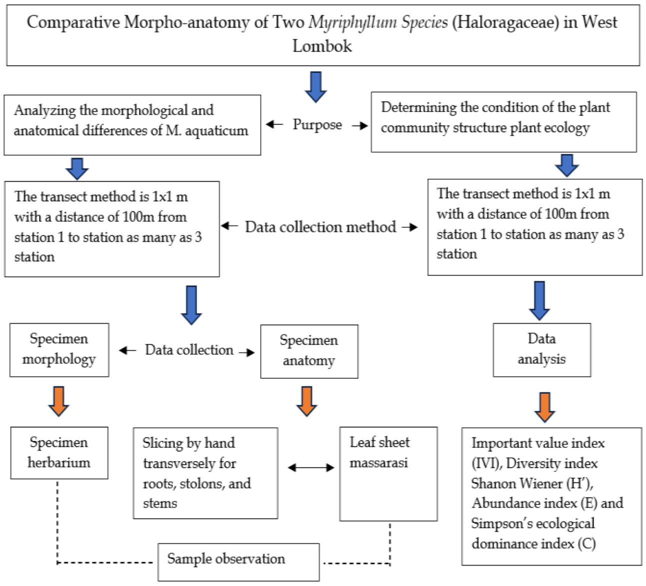

Figure 1. Research flow

This study aims to analyze the morphological and anatomical differences of *M. aquaticum* and *M. verticillatum* as well as the condition of community structure and plant ecology. Data was collected using the 1×1 meter transect method with a distance of 100 meters at three stations. The morphology of the specimen was observed directly, while the anatomy was analyzed by transverse cutting of roots, stolons, and stems as well as the preparation of leaf sheet preparations. After sample observation, the data were analyzed using the important value index (IVI), the Shannon-Wiener diversity index (H'), the abundance index (E), and the Simpson ecological dominance index (C).

Research Area

This research was carried out in July–October 2024. The sampling locations were in two places, namely the Pukro River, Nature Tourism Park Suranadi and the Sesaot River, Sesaot, West Lombok Regency. This research was continued in the Advanced Biology Laboratory, Faculty of Mathematics and Natural Sciences, University of Mataram.

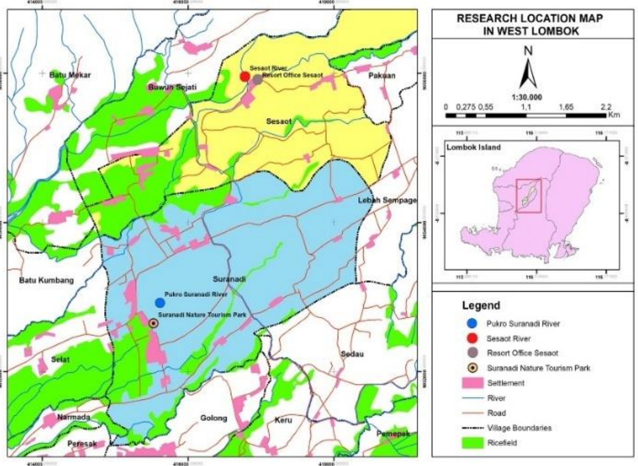

Figure 2. Map of research location

Research Tools and Materials

The tools used in this research process include: for field research cellphone with GPS formatter software application, luxmeter, thermohygrometer, camera, meter, for cameral treatment Zeiss Primo Star microscope, 50 mL bottle, petri dish, scissors, new razor, dropper pipette, slide, tweezers, brush, pestle, oven, and identified using an Excel database. Meanwhile, the materials for this research include: 50% Alcohol, 75% Alcohol, Toluidine blue O (0.025% aqueous), Safranin O 1% (50% alcohol), distilled water, label paper, tissue, drawing books, newsprint, oil paper, glue shoot and specimen *M. aquaticum* and *M. verticillatum*.

Research Procedures

M. aquaticum and *M. verticillatum* collection, first, by determining the location of the observation station and arranging the transect route points as well measuring the coordinates, temperature and light intensity at three stations located in two different places (Yudhistian et al., 2025) and each station measuring 1 x 1 m^2 with a distance of 100 m.

Herbarium a making, to be used as a herbarium are all plant organs such as roots, stolons, stems, leaves, flowers and fruit if found. Each specimen is given a hanging tag containing the specimen number, collector's name, collection date and collection location. One by one they were placed in folded newspapers. The specimens were tied to a sapling to be dried using an oven at 60 for 3 days, according to Dahlia (2020) after drying the specimens were attached to A3 drawing paper equipped with permanent hanging marks and written in an Excel database book and stored in a herbarium box and kept in the herbarium room.

Transversal anatomical slide. Prepare of fixation bottles containing 70% alcohol (roots, stolon, stem, petiole and leaf blades) measuring 1 cm each, leave for 24 hours (Sunandar & Kahar, 2017). The specimens were sliced using the free hand section method. The leaves were sliced crosswise using a new razor as thin as possible. Thin slices were placed on a glass object, dripped with distilled water, then covered with the glass object. The thickness of the slices was checked using a microscope. Thin slices were observed and the visible parts were photographed, then the cover glass was removed. Staining the specimen with drops of Toluidine Blue O (0.025%), leave for 20 minutes. The specimens were washed using 75% alcohol by dripping it, then absorbed using tissue. If it is clear, then drip with 50% alcohol, leave for 1 minute, then absorbed using tissue. The slices were dripped with distilled water, then covered using a glass cover. The preparation was observed under a microscope and photographed with a magnification of 4x, 100x, 400x.

Paradermal slide, leaf blades (leaf segments) are cut and put into a sample bottle of maceration solution, containing (60% Acetic Acid: 40% Peroxide = 1:1), left for 24 hours. The macerated specimen is taken between the paradermal tissue and mesophyll tissue using a pin, then the paradermal tissue is placed on a glass object, then washed using distilled water until the smell of Acetic Acid disappears and covered with a cover glass, then observed under a microscope. According to Filartiga et al. (2022) specimen coloring by dropping Safranin O 1% (50%) and left for 1 minute. The paradermal specimen was washed with 50% alcohol by dropping on with and absorbing using tissue until the object glass and slice transparant. According to Minati et al. (2023) the paradermal specimen was dripped with water and covered using cover glass, then observed under a microscope and photographed with a magnification of 40x, 100x, 400x.

Data Analysis

The anatomical analysis of roots, stolon, stem, petiole, and paradermal leaf segments. The mopholohy analysis of the length of the stem under water and the length of the stem above water, the number of leaves per node, the length and width of the leaves, the number of segments per leaf, the color of the leaves in the water and the color of the leaves above the surface and glands.

Important value index (IVI) is useful for determing the dominance of a over other species in area (Astiani & Manurung, 2022).

$$IVI = KR + FR \qquad (1)$$

The species diversity index (H') in a plant community is used to determine the species diversity of an ecosystem. The plant species diversity index is calculated using the Shannon-Wiener formula (Handayani et al., 2022).

$$H' = -\sum_{i-1}^{n} Pi \rightarrow Pi\ \frac{ni}{N} \quad (2)$$

The species abundance index (E) is used to determine the abundance of a species, for this the Evenness index formula is used (Anwari & Wulandari, 2017) as follows:

$$e = \frac{H'}{Log\ S} \quad (3)$$

Simpson's ecological dominance index (C) is a parameter that states the level of centralized dominance (control) of a species in an ecosystem (Rosita Latumahina et al., 2021).

$$C = \sum (Pi)^2 \rightarrow Pi\frac{ni}{N} \quad (4)$$

Result and Discussion

Morphological and anatomical features. M. aquaticum in Sesaot river and M. verticillatum in Pukro river are submerged to emergent plants that in habits aquatic and semi-aquatic habitats. The plant has slender branches with sturdy greenish stems, mostly rooted freely at the bottom and floating. Submerged shoots reach the water surface, their growth changes and begins to spread along the water surface. Broad branches develop from the nodes followed by vertical growth of the emergent stem.

Table 1. Roots Anatomical Character of *Myriophyllum aquaticum* and *M. verticillatum* West Lombok

Character	Root		
	M. aquaticum (floating)	*M. aquaticum* (on the substrate)	*M. verticillatum*
Diameter cell epidermis (µm)	27 ± 5	27 ± 5	33 ± 9
Amount of hypodermis layers	2	2	3
Shape of cortex cells	Polygonal	Polygonal-rounded	Round
Cortex cell diameter (µm)	72 ± 9	72 ± 10	106 ± 14
Cortex tissue thickness (µm)	590 ± 63	590 ± 63	847 ± 63
Diameter stele (µm)	309 ± 31	309 ± 31	277 ± 10
Amount of layers of cells aerenchyma	-	1	36
Vascular bundle type	Triarch type	Triarch type	Tetrarch type

The *M. aquaticum* leaves of heterophylla emergent and submerged, numerous, feathery and green, pinnate and arranged in whorls of 4 to 6 segments around the stem. The emergent leaves protrude up to 5-10 cm from the water surface and are soil-based, 0.5-6 cm long and have 8-26 per segment, the emergent leaves are greener than the submerged leaves. The submerged leaves are 5-8 cm long and have 8-26 per segment, the submerged leaves are brownish. The submerged leaf part of the plant is much sparser, compared to the longer and more fibrous emergent leaves around the stem. *M. aquaticum* have glands on the white stems, while *M. verticillatum* do not have glands. In the rainy season, *M. aquaticum* grows slightly because it is influenced by the strong river current, while *M. verticillatum* do not grow because they are influenced by the presence of stagnant water around their habitat (Table 1).

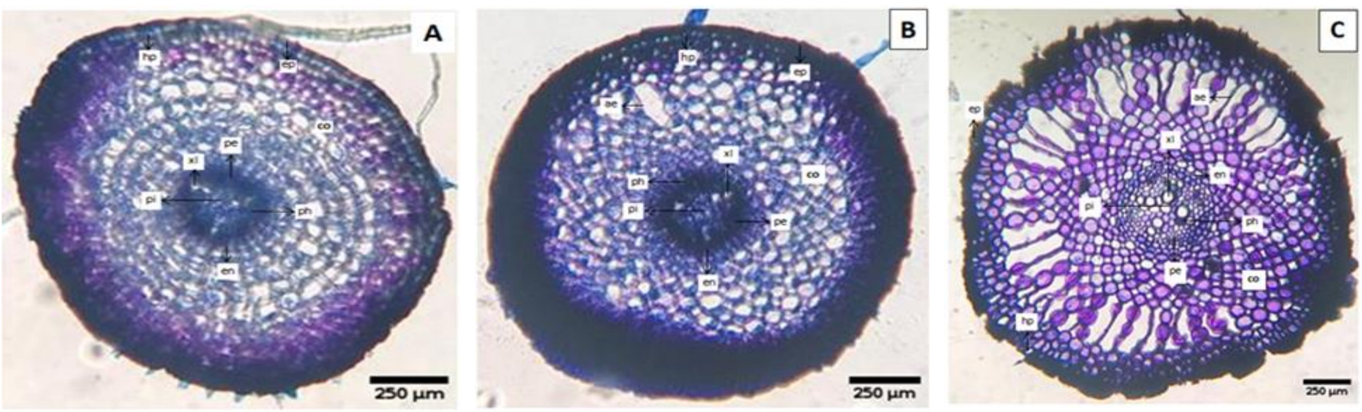

Figure 3. Roots transversal section of *Myriophyllum aquaticum* and *M. verticillatum*. Notes: A. Aquatic that grows floating and B. Aquatic which grows in soil substrate; C. Semi-aquatic; ep. Epidermis; hp. Hipodermis; co. Cortex; ae. Aerenchyma; en. Endodermis; pe. Pericycle; xl. Xilem; ph. Phloem; pi. Pith

Cross section of the root structure showing the cortex and stele tissue. Cortical tissue consists of epidermal cells, hypodermis and cortical parenchymal tissue (Prameswari & Apsari, 2017).

In the cortical parenchyma *M. aquaticum*, which grows in standing water, is composed of parenchyma only (Figure 3. A), while roots that grow in substrates are composed of parenchyma and aerenchyma tissue (Figure 3. B). However, in *M. verticillatum* root plants that grow on muddy soil substrates, the cortex parenchyma is composed of parenchyma and aerenchyma, round aerenchyma cells are arranged in a circle around the air space, some are also composed of flat cells (Figure 3. C). The inside of the stele consists of endodermis, pericycle, phloem and xylem. Plant *M. aquaticum* has a transport beam type, namely the triarch type (Figure 3. A and B), while *M. verticillatum* has a transport beam type, namely the tetrarch type (Figure 3. C).

Stolon *M. aquaticum* and *M. verticillatum* habitats has the same epidermal cell shape, which is round. The results of the study showed that aerenchyma was found more in aquatic stolons, which amounted to 25, while in semi-aquatic stolons there were only 20. The type of vascular bundles in both habitats is a collateral type. This difference in anatomical characteristics shows that the stolons *M. aquaticum* habitats have a larger structure and are specially adapted to support functions in the aquatic environment. Comparison of Statues of Stolon's anatomical characters is presented in full in (Table 2).

Table 2. Stolon Anatomical Character of *Myriophyllum aquaticum* and *M. verticillatum*, West Lombok

Character	Stolon	
	M. aquaticum	*M. verticillatum*
Epidermis cell shape	Round	Round
Diameter cell epidermis (µm)	22 ± 2	27 ± 4
Amount of hypodermis layers	1	1
Cortical sell diameter (µm)	95 ± 1	115 ± 14
Cortical tissue thickness (µm)	1531 ± 37	1249 ± 176
Diameter stele (µm)	915± 28	660 ± 119
Amount of layers of cells aerenchyma	25	20
Vascular bundle type	Collateral type	Collateral type

Cross section of the stolon structure shows the cortex tissue consisting of epidermis, hypodermis, cortex parenchyma tissue and parenchyma which has diffuse collenchyma surrounding the aerenchyma tissue (Figure 4. A and B).

The inside of the stele consists of vascular cambium, phloem and xylem. The stolon of *M. aquaticum* and *M. verticillatum* a closed type of collateral transport bundle (Figure 4. A and B).

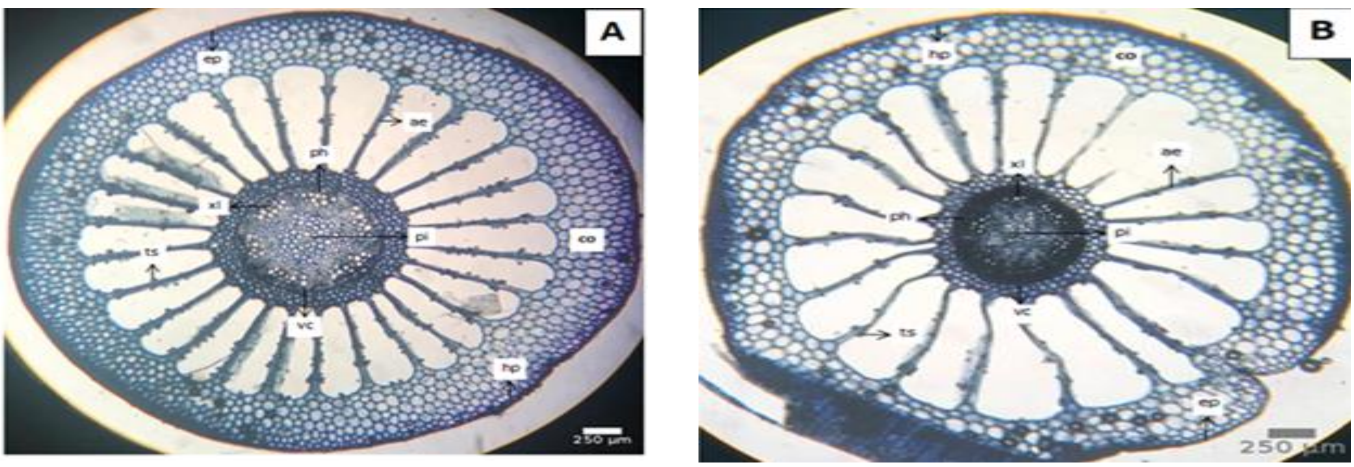

Figure 4. Stolon transversal section of *Myriophyllum aquaticum* and *M. verticillatum*. Notes: A. Aquatic; B. Semi-aquatic; ep.Epidermis; hp. Hipodermis; co. Cortex; ae. Aerenchyma; ts. Trichosclereid; vc. Vascular cambium; xl. Xilem; ph. Phloem; pi. Pith

The diameter of epidermal cells in aquatic rods is larger, which is 35 ± 10 µm, compared to semi-aquatic which is only 13 ± 2 µm. The number of hypodermis layers in both habitats is the same, one layer. The diameter of cortical cells in *M. aquaticum* rods is 108 ± 4 µm, larger than that of *M. verticillatum* which is only 68 ± 0.3 µm. The thickness of cortical tissue in *M. aquaticum* habitats is much larger, namely 1580 ± 164 µm, while in *M. verticillatum* habitats it is only 492 ± 19 µm. The diameter of the stele in the *M. aquaticum* rod was also larger (1145 ± 262 µm) than the *M. verticillatum* (277 ± 25 µm), this result is presented in (Table 3).

Table 3. Stem Anatomical Character of *Myriophyllum aquaticum* and *M. verticillatum,* West Lombok

Character	Stem	
	M. aquaticum	*M. verticillatum*
Epidermis cell shape	Rounded	Rounded
Diameter cell epidermis (µm)	35 ± 10	13 ± 2
Amount of hypodermis layers	1	1
Corticalcell diameter (µm)	108 ± 4	68 ± 0.3
Cortical tissue thickness (µm)	1580 ± 164	492 ± 19
Diameter stele (µm)	1145 ± 262	277 ± 25
Amount of layers of cells aerenchyma	28	13
Vacular bundle type	Bicollateral type	Collateral type

Aerenchyma is more commonly found in *M. aquaticum* stems, with 28 in number, compared to only 13 *M. verticillatum* ones. The type of vascular beam in *M. aquaticum* stems is bilateral type, while in *M. verticillatum*stems it is collateral type. Cross section of the stem structure shows the cortex tissue consisting of epidermis, hypodermis, cortex parenchyma tissue and aerenchyma which has protruding trichosclereids like spines surrounding the aerenchyma (Figure 4. A and B). The inside of the stele consists of vascular cambium, xylem and phloem, *M. aquaticum* have a transport bundle type, namely the closed bicollateral transport bundle (Figure 5. A), while *M. verticillatum* have open collateral transport bundle (Figure 5. A).

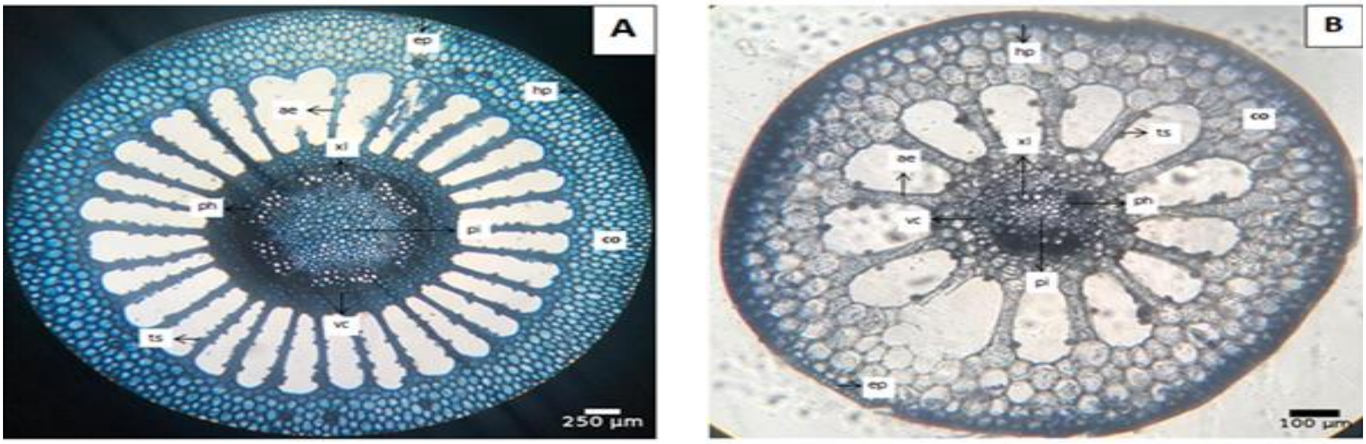

Figure 5. Stem transversal section of *Myriophyllum aquaticum* and *M. verticillatum*. Notes: A. Aquatic; B. Semi-aquatic; ep. Epidermis; hp. Hipodermis c. Cortex; ae. Aerenchyma; ts. Trichosclereid; vc. Vascular cambium; xl. Xilem; ph. Phloem; pi. Pith

The petioles of *M. aquaticum* and *M. verticillatum* show differences in anatomical character between habitats. In transverse slices, the shape of the petiole in *M. aquaticum* habitats is cylindrical, while in *M. verticillatum* habitats it is crescent-shaped. The shape of epidermal cells in both habitats is round, but the diameter of epidermal cells in *M. verticillatum* habitats (24 ± 17 µm) is larger than in *M. aquaticum* habitats (15 ± 3 µm). The number of aerenchyma networks in *M. aquaticum* habitats is only one, while *M. verticillatum* habitats there are two. The size of transverse petiole slices (length x width) in *M. aquaticum* habitats was 1040 ± 146 µm x 421 ± 4 µm, smaller than the *M. verticillatum* habitat measuring 1467 ± 636 µm x 498 ± 220 µm. The results of this study are shown in (Table 4). These differences in characteristics suggest that the petioles of *M. aquaticum* have structural adaptations to environmental conditions, with petioles in larger, more complex *M. verticillatum* habitats to adapt to wetland habitats.

Table 4. Petiole anatomical characters of *Myriophyllum aquaticum* and *M. verticillatum,* West Lombok

Character	Petiole	
	M. aquaticum	*M. verticillatum*
From a transverse slice on the leaf stalk	Cylinder	Crescent moon
Papilla cells	-	There is
Epidermal cell shape	Rounded	Rounded
Diameter cell epidermis (µm)	15 ± 3	24 ± 17
Amount of aerenchyma tissue	1	2
Transverse section size of petiole (L × D) (µm)	1040 ± 146 × 421 ± 4	1467 ± 636 × 498 ± 220

Cross section of the petiole structure shows the cortex tissue components which have upper and lower epidermal cells. Petiole aquatic plant *M. aquaticum* do not have papillae (Figure 6. A), whereas *M. verticillatum* have papillae. *M. aquaticum* and *M. verticillatum* plants each have vascular bundles composed of phloem and xylem (Figure 6. A and B).

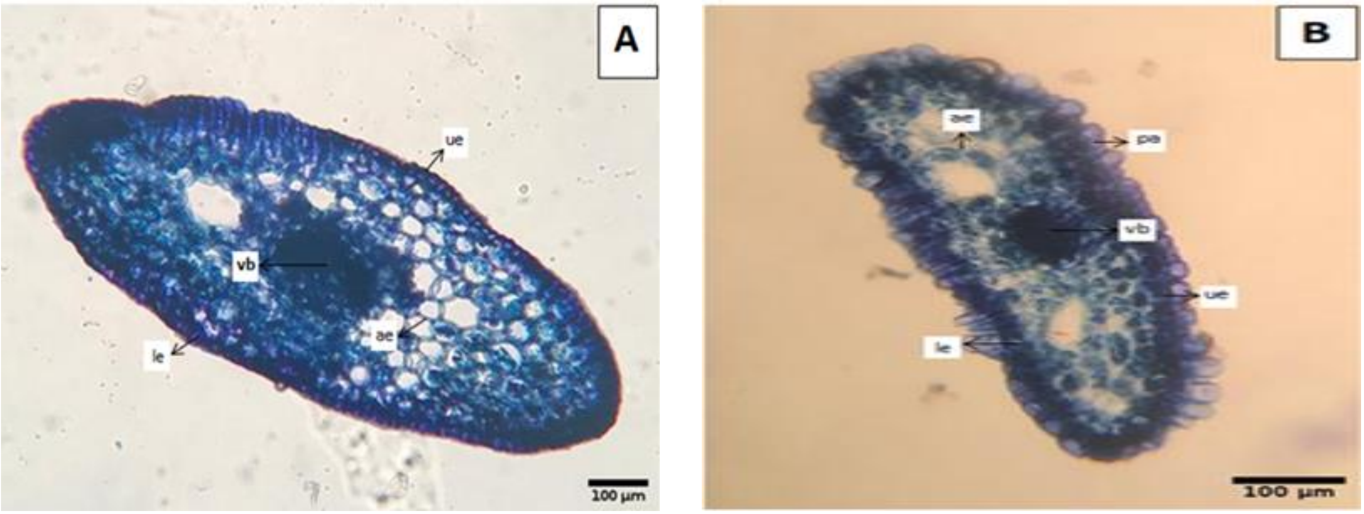

Figure 6. Petiole transversal section of *Myriophyllum aquaticum* and *M. verticillatum*. Notes: A. Aquatic; B. Semi-aquatic; pa. Papila; ue. Upper epidermis; le. Lower epidermis; c. Cortex; ae. Aerenchyma; vb. Vascular bundle

The results showed that the paradermal character of *M. aquaticum* and *M. verticillatum* had differences between habitats, the difference in antomimes and morpholohy is shown in full (Table 5).

Stomata is one of the derivatives of epidemic cells that have important functions for plants. Therefore, epidermal cells and stomata are closely related, so environmental factors that affect the epidermal cells will also affect the stomata (Nyainleta et al., 2022). Stomata can be divided into several types, one of which his based on the number and arrangement of neighboring cells. In *M. aquaticum* this type of stomata is actinocytic if the guard cells are surrounded by a number of cells that cannot be differentiated in size and shape from other epidermal cells (Figure 7. A) (Sarjani et al., 2017) while *M. verticillatum* others have a parasitic stomata type if the number and arrangement of neighboring cells is where each guard cell is accompanied by neighboring cells which are located parallel to the stomatal axis (Figure 7. B) (Aulia et al., 2023). Epidermal cells which are daughter cells do not have chlorophyll, while the guard cells of the stomata contain chlorophyll, organic phosphate, and phosphorylase enzymes, and in the morning there is still a little starch in them (Vialet-Chabrand et al., 2017). The results of measuring the length and width of the stomata of the two *Myriophyllum* species showed differences in size. The difference in size is most likely caused by genetic factors which are more dominant than environmental factors (Nyainleta et al., 2022).

Table 5. Paradermal Character of *Myriophyllum aquaticum* and *M. verticillatum*, West Lombok

Character	Paradermal	
	M. aquaticum	*M. verticillatum*
Epidermal cell shape	Spatula	Polygonal
Epidermal cell size (W × D) (µm)	138 ± 2 × 91 ± 1	65 ± 1 × 64 ± 0.2
Amount of epidermal cells (in the field of view)	15	17
Stomata type	Actinocytic	Paracytic
Stomata diameter (W × D) (µm)	59 ± 4 × 47 ± 2	49 ± 6 × 42 ± 1
Amount of stomata (in field of view)	1	4

Morphology character of *M. aquaticum* and *M. verticillatum* (Figure 7). The morphology of *M. aquaticum* species in the Sesaot River (aquatic) phyllotaxis was whole, 5-6 leaves/node, parypinnate compoud leaves with 18-27 segment/leaf, fili white folia-glands on the based of petioles and extrapetiolaris. Meanwhile, in *M. verticillatum* habitats, the phyllotaxis was whole 4-5 leaves/node, impary pinnate compound leaves with 8-9 segments/leaf, segment/leaflet alternate, its has'nt folia-glands. *M. verticillatum* has roots and *M. aquaticum* both have fibrous roots with different habitat conditions (Lambers et al., 2006).

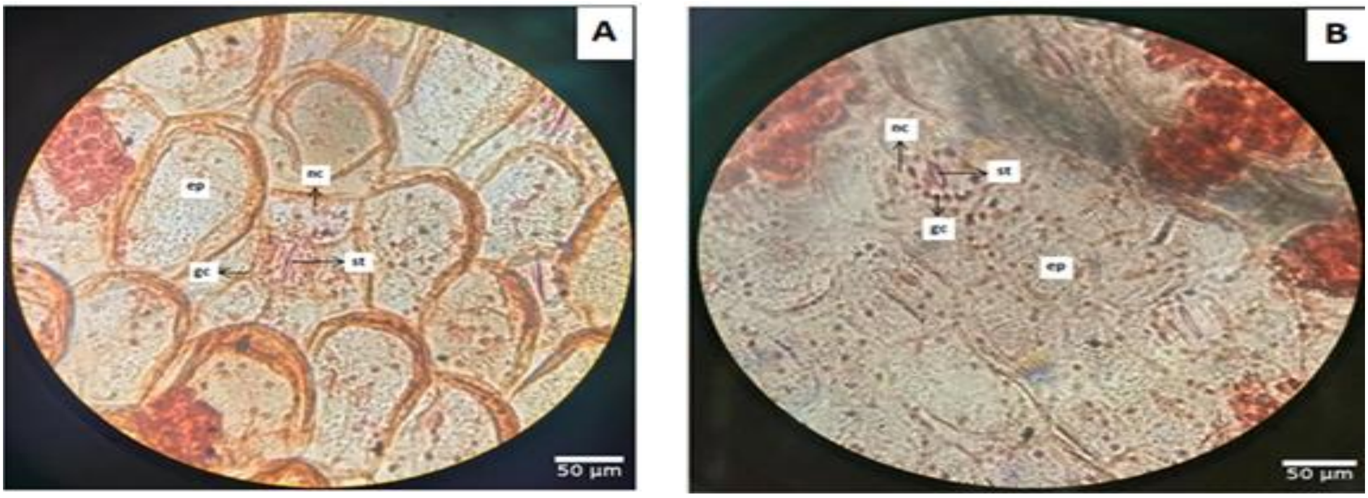

Figure 7. Paradermal of *Myriophyllum aquaticum* and *M. verticillatum*. Notes: A. Aquatic; B. Semi-aquatic; st. Stoma; ep. Epidermis; gc. Guard cell; nc. Neighboring cells

Table 6. Morpholoogy character of *Myriophyllum aquaticum* and *M. verticillatum,* West Lombok

Character	Paradermal	
	M. aqauticum	*M. verticillatum*
The height of the emergent plant (cm)	5 – 10	15
Height of sugmerged plants (cm)	5 – 8	-
Leaf width	2 ±	0.5 ±
Phyllotaxis of leaf	Opposite	Alternated
Leaf type	Parypinnate	Imparypinnate
Amount of leaves in a node	6 ±	4 ±
Amount of leaflet	19 ±	9 ±
Folia-glands location	In the based of petioles and extrapetiolaris	-
Folia-glands color	White	-
Length stolon max	5 ±	2 ±
Presence of turions	2 ±	-
Length of the longest root	9 ±	6 ±

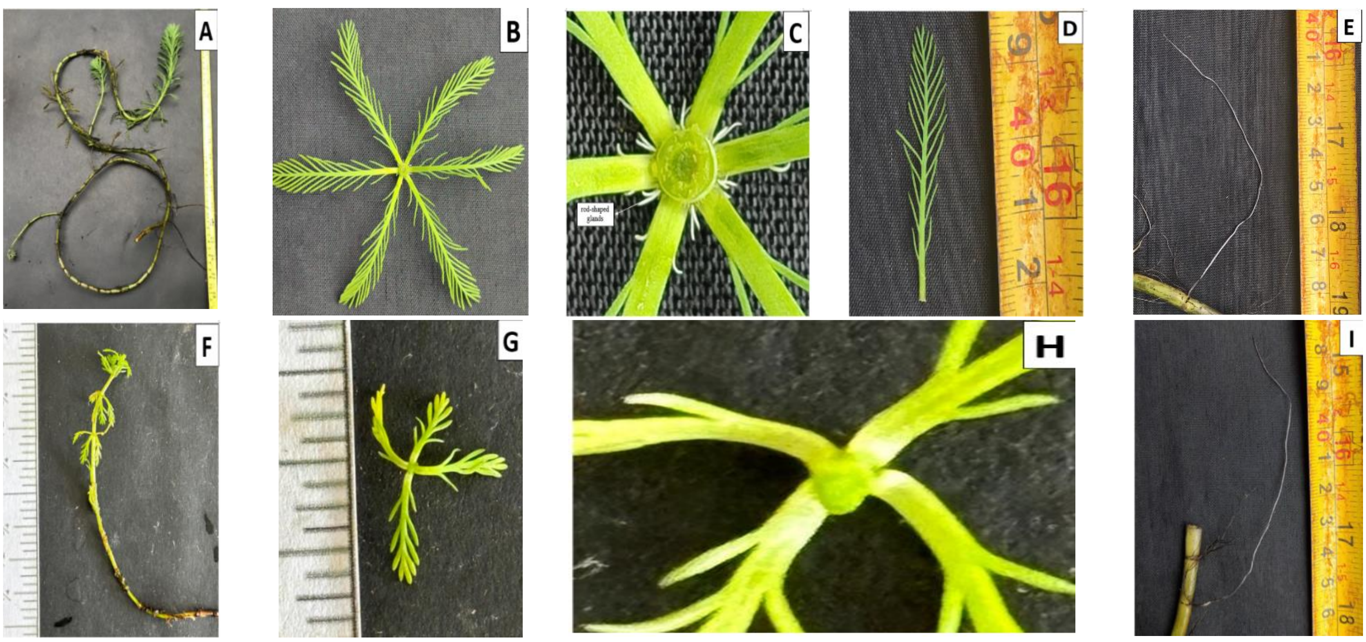

Figure 8. Morpholohy of *Myriophyllum aquaticum* and *M. verticillatum* West Lombok. Notes: A-E. *M. aquaticum* macrophyt in Sesaor river; A. Habitus; B. Phillotaxis; C. Foliaglands; D. Leaves; E, I. Stolon and roots. F-I. *M. verticillatum* macrophyt in Pukro river; F. Habitus; G. Phyllotaxis; H. Petioles whitaout foliaglands

Table 7. Distribution and Proportion of Major Taxonomic and Ecological Group in *Myriophyllum aquaticum* and *M. verticillatum* Communities

Plant community	Family amount	Families	Genera amount	Genera	Species amount	Species
M. aquaticum						
Submerged plants	1	≥ 1.0	1	≥ 1.0	1	≥ 1.0
Floating-emergent	1	≥ 1.0	1	≥ 1.0	1	≥ 1.0
Emergent	4	≤ 1.0	4	≤ 1.0	4	≤ 1.0
M. verticillatum						
Free drifting	1	≥ 1.0	1	≥ 1.0	1	≥ 1.0
Emergent	6	≤ 1.0	6	≤ 1.0	6	≤ 1.0

Based on the research results, the number of plant tribes found in the Sesaot River and Pukro River area is 13 species The total distribution of tribes found at all aquatic and semi-aquatic plan sampling points influences the number of plant types. According to (Vauzia et al., 2023) differences in morphological characteristics in the data of this study were influenced by temperature and humidity at both locations. States that the condition of air temperature in an area or area is closely related to the altitude of the place.

Table 8. Environmental Parameter in *Myriophyllum aquaticum* and *M. verticillatum* Communities

Environmental parameters	Rate-rate ± SD
M. aquaticum	
Water temperature (°C)	26.27 ± 1.242
Air temperature (°C)	31 ± 0
Light intensity (lux)	7368. 67 ± 28.023
Water height (cm)	37 ± 0
Soil moisture (%)	90 ± 5
M. verticillatum	
Air temperatur(°C)	31 ± 0
Light intensity (lux)	6013.33 ± 7.637
Soil moisture (%)	89.66 ± 5.033

Analysis of environmental parameters in *M. aquaticum* habitats at Sesaot River and *M. verticillatum* Pukro River, West Lombok shows various physical and chemical conditions that influence the local ecosystem. The water temperature is an average of 26.27 °C and the air temperature is an average of 31 °C in Sesaot River, according to (Isnaini & Aryawati, 2023), the optimal temperature for growth of *M. verticillatum* is between ± 32 °C, which is the optimal temperature for *M. aquaticum* habitats, 31 °C in Pukro River which is the optimal temperature. Consistent growth of aquatic plants is found in the minimum temperature range of 18 C, optimum temperature (25 - 30) °C and at a temperature of (33 - 35) °C reaching the highest growth rate for *M. aquaticum* and *M. verticillatum* habitats (Nurdin et al., 2023). The average light intensity in Sesaot River was 7368.67 lux and in Pukro River was 6013.33 lux, the average water level was 37 cm and the average soil moisture was 90% in Sesaot River and 89.66% in Pukro River which may indicate variations in soil conditions from very moist to moist which may affect species that can grow around the river (Table 8).

The *M. aquaticum* community in Sesaot River and *M. verticillatum* Pukro showed differences between habitats, as seen in (Figure 8). The habitat of *M. aquaticum* (Figures A and B), growing with submerged leaves, showed adaptation to the aquatic environment. Meanwhile, in *M. verticillatum* the habitat average light intensity of 7368.67 lux in Sesaot River and 6013.33 lux in Pukro River, average water level value of 37 cm and average soil moisture of 90% in Sesaot River and 89.66% in Pukro River which can indicate variations in soil conditions from very humid to humid which can affect the types that can grow around the river (Table 8). The *M. aquaticum* community in Sesaot River and *M. verticillatum* Pukro show differences, as seen in (Figure 8). The habitat of *M.aqauticum* (Figures A and B), grows with submerged leaves, indicating adaptation to the aquatic environment. Meanwhile, *M. verticillatum* (Figures C and D), the habitat grow in areas with high humidity but are not completely submerged, with leaves that tend to be more upright (Figures C and D), these plants grow in areas with high humidity but are not completely submerged, with leaves that tend to be more upright.

The results showed that the *M. aquaticum* and *M. verticillatum* plant communities at the research site consisted of several species with varying degrees of dominance. In ecosystems *M. aquaticum* has the highest species importance value (IVS) of 67.17, followed by *Hydrilla verticillata* with IVS of 37.44 (Figure 9). According to Riska et al. (2023) this shows that *M. aquaticum* is the dominant species in *M. aquaticum* habitats. In contrast, species such as *Alternanthera philoxeroides* and *Persicaria moculosa* have lower IVS, indicating a more limited distribution.

The higher the value of the species diversity index (H'), according to (Nasir et al., 2019) the range of species diversity index (H') is between 1-3. The value range H < 1 means low diversity, if H = 1 < 3 means medium diversity and if H > 3 means high diversity (Handayani et al., 2022).

Figure 9. Plant community of *Myriophyllum aquaticum,* in Sesaot river and *M. verticillatum*, Pukro river West Lombok. Note: A. Aquatic plant; B. Semi-aquatic plant

Species abundance index (E), according to Astiani et al. (2022) states that the species abundance index ranges from 0 to 1, if e approaches the value 1, then the species abundance index is the same or evenly distributed, while e < 1, then the species abundance index is uneven. Simpson's ecological dominance index (C), based on the results of data analysis in (Table 9), it is known that the average.

Table 9. Species and Family Plant Association with *Myriophyllum aquaticum* and *M. verticillatum*, West Lombok

Location, family, species name	Local name	D	Rd	Fi	FR	IVI	H'	E	C
Sesaot river									
Haloragaceae									
Myriophyllum aquaticum (Vell.) Verdc.	Chicken feathers water foxtail plants	70	55.4	0.12	11.76	67.17	0.32	0.00	0.31
Polygonaceae									
Eleusine indica (L) Gaertn.	Bone grass	4.3	3.4	0.18	17.65	21.08	0.01	0.00	0.00
Amarantheraceae									
Alternanthera philoxeroides (Mart.) Griseb.	Crocodile grass or Dempo	1.3	1.1	0.12	11.76	12.82	0.37	0.06	0.00
Hydrocharitaceae									
*Hydrilla verticillata (*L.f.) Royle.	Algae	25	19.8	0.18	17.65	37.44	0.67	0.00	0.00
Asteraceae									
Ageratum connyzoides L.	Bandotan	6.67	5.3	0.18	17.65	22.92	0.02	0.00	0.00
Polygonaceae									
Persicaria moculosa Gray.	Sujak	9	7.1	0.06	5.88	13.01	0.03	0.00	0.00
Commelinaceae									
Commelina diffusa Burm.f.	Brambangan	10	7.9	0.18	17.65	25.56	0.03	0.00	0.00
Pukro river									
Amarantheraceae									
Alternathera philoxendroides (Mart.) Griseb.	Crocodile grass or Dempo	0.17	16.67	3.67	36.67	53.33	0.36	0.07	0.13
Pontederiaceae									
Pontederia vaginalis Burm.f.	Small watercress or Wewehan	0.17	16.67	0.33	3.33	20.00	0.00	0.00	0.00
Cyperaceae									
Cyperus rotundus L.	Puzzel grass	0.08	8.33	0.33	3.33	11.67	0.00	0.21	0.00
Haloragaceae									
Myriophyllum verticillatum L.	Chicken feather or Water foxtail plants	0.25	25.00	3.67	36.67	61.67	0.04	0.08	0.00
Araceae									
Pistia stratiotes L.	Apu wood or Ai lettuce or Water cabbage	0.17	16.67	1.00	10.00	26.67	0.00	0.12	1.00
Syngonium podophyllum Schott.	Uruwakung	0.08	8.33	0.33	3.33	11.67	0.00	0.00	0.00
Asteraceae									
Mikania scandens (L.) Willd.	Connect	0.08	8.33	0.67	6.67	15.00	0.01	0.12	0.00

Notes: D. Density; Rd. Relative Density; Fi. Frequency; Fr. Relative Frequency; IVI. Importance Value Index; H'. Shannon-Wiener diversity index; E. Species Abundance Index; C. Simpson's Ecological Dominance Index.

The calculation of the Important Value Index (IVI) was used to describe the level of distribution and dominance of each species identified in the field (Nanlohy et al., 2024). The diversity index (H') for the *M. aquaticum* community was 0.31, while the *M. verticillatum* community had a higher H' value, which was 0.04 (Figure 9). This value indicates that *the M. aquaticum* and *M. verticillatum* communities mean that the H≤1 value indicates that the species diversity is low. This is likely due to the variation in environmental conditions that are less dynamic in the habitats *of M. aquaticum* and *M. verticillatum*, thus supporting fewer species, indicating that the ecosystem does not only have many different species. The results of this calculation can also describe unstable environmental conditions (Safei et al., 2021).

The species abundance index (E) for the *M. aquaticum* community was 0.00, while the *M. verticillatum* community had a value of 0.08 (Table 9). Uniformity value indicating the difference that the distribution of species in both ecosystems is not relatively even. Simpson's Dominance Index in M. aquaticum is C = 0.3 and *M. verticillatum* is C = 0.00 which means that both are in stable conditions (Rosita Latumahina et al., 2021).

Conclusion

Based on the results of the study, it was concluded that there were differences in the morphological and anatomical characteristics of the habitats of *M. aquaticum* and *M. verticillatum*. Morphologically, the stem of *M. aquaticum* contains glands, while the plant *M. verticillatum* does not. Anatomically, the differences are seen in the roots, stems, leaf stalks, and leaf blades. *M. aquaticum* that grows floating in the air has aerenchymal tissue in its roots, while those growing on soil substrates do not have this tissue. In addition, the cortex cells in the stem of *M. verticillatum* are larger than those of *M. aquaticum*. *M. verticillatum* also has larger aerenchymal tissue, although less in number, compared to *M. aquaticum*. This difference reflects the instability of the environment of each habitat. This study also found that *M. aquaticum* dominates the aquatic community, with the highest species importance value (IVI) of 67.17, *while Alternanthera philoxeroides* and *Persicaria moculosa* have lower (IVI) values of 61.67. The diversity index (H') of *M. verticillatum* and *M. aquaticum* was classified as low, with values (H' = 0.04 and 0.00). (E) was relatively even, with a value of 0.00 for the *M. aquaticum* community and 0.08 for the *M. verticillatum* community. Finally, the Simpson dominance index (C) showed that the *M. aquaticum* and *M. verticillatum* communities were equally stable.

Acknowledgements

The author would like to express his deepest gratitude to the Dean of the Faculty of Mathematics and Natural Sciences, and the Rector of the University of Mataram for their support in providing the research equipment needed for this research. Their commitment to advancing academic research and facilitating access to essential resources has greatly contributed to the completion of this work.

Author Contributions

All authors contributed to writing this article.

Funding

No external funding.

Conflicts of Interest

No conflict interest.

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