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Morphological and Trichome Characteristics of *Pyrrosia* (Polypodiaceae) at Andalas University

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Abstract: Pteridophyta, a group of vascular cryptogams, demonstrate remarkable adaptability to a wide range of environmental conditions. Within this group, the genus *Pyrrosia* (Polypodiaceae) is particularly notable for its unique morphological adaptations and the presence of trichomes key features in taxonomic identification and species delimitation. This study investigates the morphological characteristics and trichome structures of *Pyrrosia* species growing in the vicinity of Andalas University, West Sumatra, Indonesia. Field sampling was conducted through systematic exploration in the Biological Garden of the Faculty of Mathematics and Natural Sciences, Andalas University. Specimens were collected and examined using a binocular light microscope (Sinher XSZ-107) to observe the morphology of primary vegetative organs roots, rhizomes, and leaves as well as trichome characteristics on the leaf surface. Three *Pyrrosia* species were identified: *P. angustata*, *P. piloselloides*, and *P. adnascens*. Distinct morphological differences were observed among them. The sterile leaves of *P. angustata* are lanceolate, while those of *P. piloselloides* and *P. adnascens* are oblong. The fertile leaves also vary: lanceolate in *P. angustata*, elliptical in *P. piloselloides*, and narrowly pointed in *P. adnascens*. A consistent feature across all three species is the presence of stellate (star-shaped) trichomes, a characteristic of taxonomic significance within the genus. The findings of this study contribute to a better understanding of morphological variation within *Pyrrosia* and reinforce the importance of micromorphological traits, particularly trichomes, in supporting species identification and classification within the Polypodiaceae.

Keywords: Morphology, P. *piloselloides*, Polypodiaceae, Stelata, Trichomes

Introduction

Pteridophytes represent a group of vascular plants that exhibit significant ecological adaptability, allowing them to thrive across diverse habitats, including both large and small islands (Mildawati et al., 2020). As members of the cormophyte group, pteridophytes are characterized by the presence of distinct morphological organs true roots, stems, and leaves (Halimatun et al., 2024). One of the defining features of this group is their mode of reproduction through spores, which are typically located on the abaxial surface of their fronds. This spore-based reproductive strategy distinguishes them from seed plants and underscores their evolutionary uniqueness (Ulfa et al., 2023).

Numerous studies have investigated the morphological diversity of pteridophytes, particularly within taxonomically complex genera such as *Davallia* (Mildawati et al., 2022). One genus of increasing interest is *Pyrrosia*, a member of the Polypodiaceae family. Species of *Pyrrosia* commonly exhibit an epiphytic growth habit, frequently colonizing tree trunks and rocks

(Adlini et al., 2021). The Polypodiaceae family is recognized for its high species richness and broad geographic distribution, a pattern attributed to the ecological adaptability of its members across various microhabitats and altitudinal gradients (Arise & Sofiyanti, 2023; Dita et al., 2018).

The high morphological variability within *Pyrrosia* and related taxa poses a challenge for accurate identification and classification. Nonetheless, morphological traits, including frond architecture and the presence, type, and distribution of trichomes, have proven valuable in species delimitation and taxonomic studies within the Pteridophyta (Sofiyanti & Isda, 2018). Despite its relevance, no prior research has addressed the morphological and trichome characteristics of *Pyrrosia* species in the vicinity of Andalas University.

This study aims to analyze the morphological features and trichome types of *Pyrrosia* species collected around the Andalas University campus. The findings are expected to contribute to a better understanding of species delimitation within the genus and to provide novel data for regional floristic inventories and plant taxonomy.

Materials and Methods

Materials

The plant materials used in this study were specimens of the genus *Pyrrosia* (Polypodiaceae) collected from the surroundings of the Andalas University campus, particularly in the vicinity of the Department of Biology, Faculty of Mathematics and Natural Sciences. The tools and equipment utilized included a light microscope (Sinher Binocular Microscope, model XSZ-107), a digital camera for documentation, glass slides, cover slips, a razor blade, a measuring tape, and styrofoam for specimen support during preparation.

Methods

This research employed an exploratory field survey combined with laboratory-based morphological and microscopic analysis. Specimens of *Pyrrosia* were collected through purposive sampling based on the presence of observable fronds and trichome structures. Each collected sample was tagged, documented, and transported for further analysis. Macromorphological observations were conducted to examine features such as frond shape, size, venation pattern, and attachment type. For micromorphological analysis, especially trichome identification, leaf samples were sectioned manually using a sterile razor blade to obtain thin transverse slices. These sections were then mounted on glass slides with cover slips and observed under a light microscope (Sinher Binocular Microscope, XSZ-107) at appropriate magnifications. Trichomes were characterized based on their type, size, distribution, and density across the lamina surface. Descriptive data were recorded, photographed, and categorized for comparison among specimens. All morphological traits were analyzed to aid in distinguishing interspecific variation within the genus *Pyrrosia*.

Results and Discussion

Pteridophyta represent a group of vascular cryptogamic plants characterized by the production of spores as reproductive units, distinguishing them from seed-bearing plants (Vijayakanth & Sathish, 2016). Although often categorized as lower plants, pteridophytes have undergone considerable evolutionary advancement compared to other non-seed plant groups, as demonstrated by recent phylogenetic studies (Mildawati et al., 2023). They possess vascular tissues xylem and phloem which facilitate the efficient transport of water, nutrients, and photosynthates throughout the plant body (Carlquist & Schneider, 2001). This structural adaptation sets them apart from non-vascular cryptogams, placing them firmly within the vascular cryptogam clade (Saha et al., 2014).

Among the diverse genera within Pteridophyta, *Pyrrosia* is of particular interest. Belonging to the family Polypodiaceae, members of this genus are predominantly epiphytic, commonly found growing on tree trunks and rock surfaces (Roziaty et al., 2016). As epiphytes, they exhibit a non-parasitic relationship with their host, deriving moisture and nutrients from the surrounding environment rather than from the host itself. Through photosynthesis, these plants synthesize their own food, allowing them to thrive independently, even in nutrient-poor or moisture-limited habitats.

In this study, three species of *Pyrrosia* were identified from the Andalas University campus: *Pyrrosia angustata*, *Pyrrosia piloselloides*, and *Pyrrosia adnascens*. These species exhibit distinctive morphological traits that aid in their identification. *P. angustata* is recognized by its narrow leaves and compact growth habit, whereas *P. piloselloides* features hairy leaves and a more prostrate form. *P. adnascens*, in contrast, has uniquely shaped leaves and a more upright growth habit (Sofiyanti & Isda, 2018). A notable morphological feature across all three species is the presence of long, creeping rhizomes, which enhance anchorage and nutrient acquisition in their epiphytic habitats. All observed *Pyrrosia* species possess simple leaves, with each petiole bearing a single blade. The genus is also characterized by the presence of two distinct leaf types: fertile and sterile. Fertile leaves bear sori spore-producing structures essential for reproduction—while sterile leaves lack these reproductive features. The presence and characteristics of these leaf types, along with trichome morphology, provide valuable diagnostic traits for species identification. A comparative summary of morphological and trichome characteristics observed in the three *Pyrrosia* species is presented in **Table 1**.

Table 1. Comparison of morphological characteristics and trichomes in *Pyrrosia*

No	Character	*Pyrrosia angustata*	*Pyrrosia piloselloides*	*Pyrrosia adnascens*
Morphological Characteristics				
1	Growth	Spreading	Spreading	Spreading
2	Trunk	Rhizoma	Rhizoma	Rhizoma
3	Rhizoma shape	Round	Round	Round
4	Rooting	Fibrous roots	Fibrous roots	Fibrous roots
5	Leaf surface	Slick	Slick	Slick
6	Fertile and sterile leaves	Separate	Separate	Separate
7	Fertile leaf shape	Lanseolate (blunt leaf tip, pointed leaf base)	Rounded leaf tip, tapered leaf base (jorong)	Pointed leaf tip blunt leaf base
No	**Character**	***Pyrrosia angustata***	***Pyrrosia piloselloides***	***Pyrrosia adnascens***
8	Sori	Brown	Brown	Brown
9	Sterile leaf shape	Lanset	Oblong	Oblong
Characteristics of Trichomes on the Lamina				
10	Color	White	Reddish white	Reddish white
11	Shape	Stelata	Stelata	Stelata
12	Number of sleeves	8	8	8

Morphological Characteristics of *Pyrrosia angustata*

Pyrrosia angustata exhibits several distinct morphological features that facilitate its adaptation to epiphytic habitats. The plant possesses **dark brown fibrous roots**, which function primarily in the absorption of water and nutrients from the surrounding environment. The root surface is covered with dark brown **root hairs**, aiding in moisture retention and substrate adherence.

The **stem** is a long, creeping **rhizome** with a cylindrical or round cross-section. This rhizomatous stem enables the plant to anchor itself firmly to surfaces such as tree trunks or rocks and allows for horizontal spread. The species produces two distinct **leaf types**: **fertile** and **sterile**. Fertile leaves are **lanceolate** in shape and arranged **alternately** along the rhizome. They are characterized by the presence of **brown sori**, which are regularly distributed along the leaf margins and form small spherical clusters. These sori function as spore-producing structures and are essential for the reproductive cycle of the species. Sterile leaves, on the other hand, are also **lanceolate**, with **blunt apices**, **acute to pointed**

bases, **entire (flat) margins**, and a **smooth upper surface**. These leaves are notable for their **thick, fleshy texture** and **soft consistency**, adaptations that help retain moisture in the epiphytic environment. A distinguishing feature of *P. angustata* is the presence of **stellate (star-shaped) trichomes** on the leaf surface. These trichomes may play a role in minimizing water loss and protecting the leaf surface from desiccation and herbivory.

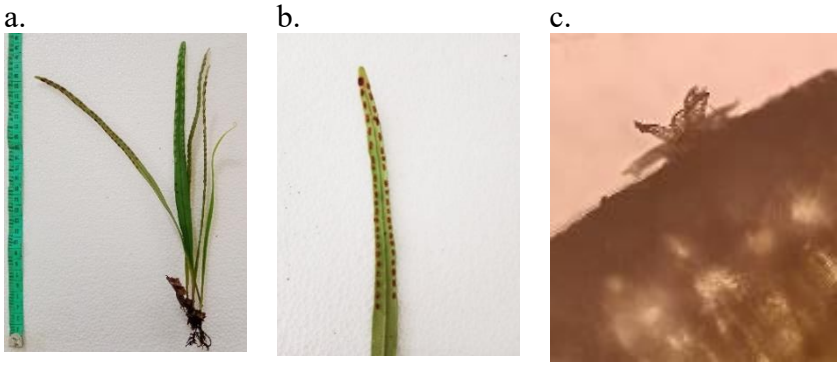

Figure 1. *Pyrrosia angustata* fern plant. a. morphology of *Pyrrosia angustata*, b. Sorus arrangement and c. Trichomes.

Morphological Characteristics of *Pyrrosia piloselloides*

Pyrrosia piloselloides is an epiphytic fern species characterized by its **herbaceous growth form** and distinctive morphological features. The plant develops **fibrous roots** covered with **fine root hairs**, which assist in anchoring the plant to host surfaces and aid in nutrient and water absorption. The **rhizome** is long, creeping, and **cylindrical**, exhibiting a **dark brown coloration** and bearing conspicuous **scales** along its surface (Lindasari et al., 2015). This rhizomatous structure provides stability and facilitates vegetative spread in epiphytic habitats. The species produces two distinct types of leaves: **sterile** and **fertile**, which differ markedly in morphology (Sofiyanti et al., 2019). The **fertile leaves** are generally **smaller** than the sterile ones and exhibit a **strap-like shape** with **rounded apices** and **tapered to slightly jagged bases**. A unique feature of the fertile leaves is the distribution of **sori**, which are restricted to the **distal two-thirds** of the leaf surface (Sofiyanti et al., 2021). These sori contain the sporangia that facilitate spore production and dispersal. In contrast, the **sterile leaves** are **oblong**, with **rounded apices**, **tapering bases**, and **entire margins**. Both the upper and lower leaf surfaces are densely covered with **trichomes**, which are star-shaped and may function in reducing water loss and offering protection from desiccation and herbivory. The leaves are supported by **dark green petioles** and exhibit a **fleshy, thick texture** and **soft consistency**, characteristics that aid in moisture retention under epiphytic conditions. The **light green coloration** of the sterile leaves contrasts distinctly with the surrounding environment, potentially enhancing light capture. The adaptive features of *P. piloselloides*, including its leaf dimorphism, trichome morphology, and robust rhizomatous system, underscore its specialization for survival in nutrient-limited, moisture-variable epiphytic niches.

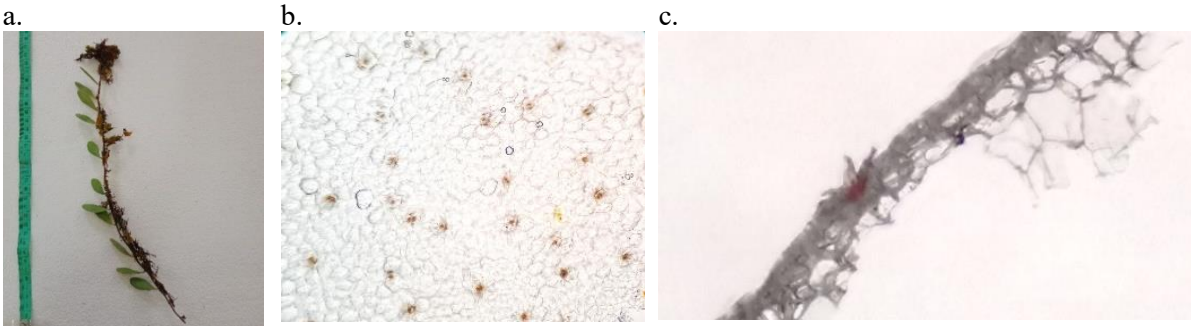

Figure 2. *Pyrrosia piloselloides*. a. morphology of *Pyrrosia piloselloides*. and b, c. trichomes.

Morphological Characteristics and Adaptive Traits of *Pyrrosia adnascens*

Pyrrosia adnascens is an epiphytic fern species exhibiting distinct morphological and reproductive adaptations. One of its most prominent features is the presence of **densely arranged, brown, round sori** that are scattered from the center to the apex of the leaf lamina, forming a **regular and diagnostic distribution pattern**. These sori are located exclusively on **fertile leaves**, which are clearly differentiated from sterile ones. The **fertile leaves** are longer and have **more pointed apices**, indicating their specialized role in reproduction, whereas the **sterile leaves** are **shorter**, with **tapering tips** and primarily serve photosynthetic functions. The **leaf laminae** are green and arranged in distinct rows, supporting optimal light capture in epiphytic habitats. Both leaf types exhibit **star-shaped (stellate) trichomes** on the surface, a characteristic trait of the *Pyrrosia* genus. These **stellate trichomes**, present across various organs such as leaf blades, petioles, and occasionally reproductive structures, are believed to provide protective functions against herbivory and environmental stresses (Sofiyanti & Isda, 2018; Watts & Kariyat, 2022).

The species also possesses a **creeping rhizome** with a **dark brown coloration**, which serves as a vegetative propagation organ. This rhizome is supported by **dense, fibrous roots** that anchor the plant to substrates and facilitate efficient nutrient absorption (Adjie et al., 2022). The robust nature of the rhizome-root complex suggests an **adaptation to epiphytic or lithophytic environments**, enabling the plant to persist in nutrient-limited and moisture-variable conditions. Trichomes on the leaf surface play a crucial role in **modulating interactions with biotic and abiotic stressors**. They function as a **defensive barrier** against herbivorous insects and pathogens, and can reduce water loss by increasing surface reflectance and epidermal thickness (Wang et al., 2021; Lusa et al., 2015). The **stellate morphology** of the trichomes in *P. adnascens* may enhance these functions by increasing surface complexity, further emphasizing the genus's ecological specialization. Overall, the **combination of distinct leaf dimorphism, structured sori placement, and specialized epidermal features such as trichomes** underlines the adaptive strategies of *Pyrrosia adnascens* within its epiphytic niche.

Figure 3. *Pyrrosia adnascens* a. Fertile *Pyrrosia adnascens* mycology, b. Sterile *Pyrrosia adnascens*, morphology, c. Sorus arrangement and d, e trichomes.

Conclusion

This study concludes that the three *Pyrrosia* species identified at Andalas University—*Pyrrosia angustata*, *Pyrrosia piloselloides*, and *Pyrrosia adnascens* share several common morphological traits, including the presence of rhizome-based roots, thick and succulent leaves, smooth leaf surfaces, and green laminae. Each species exhibits leaf dimorphism, characterized by distinct morphological differences between sterile and fertile leaves. A notable shared feature among all three species is the presence of **stellate (star-shaped) trichomes**, which likely play a functional role in ecological adaptation and species identity within the genus. Despite these similarities, clear morphological distinctions exist that facilitate species differentiation. *P. angustata* is characterized by **lanceolate-shaped sterile and fertile leaves**, whereas *P. piloselloides* and *P. adnascens* possess **oblong sterile leaves**, with their fertile leaves differing in shape **elliptic in *P. piloselloides*** and **narrow-pointed in *P. adnascens***. These leaf shape variations represent key diagnostic characters and reinforce the utility of detailed **morphological analysis** in the taxonomic identification and delimitation of *Pyrrosia* species. These findings underscore the taxonomic significance of both vegetative and reproductive morphological traits in epiphytic ferns, particularly in diverse genera such as *Pyrrosia*, and highlight the importance of field-based morphology studies as a complementary approach to molecular data in fern systematics.

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