Ethnopteridological knowledge of Afro-descendant communities in the humid forest of Chocó, Colombia

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Research

Abstract

Background: Ferns are of great utility to neighboring communities due to their wide diversity of uses, ranging from medicinal to magical-religious applications. The Afro-Colombian population possesses a rich ethnobotanical tradition, making it an ideal setting for exploring ethnopteridological knowledge. This study documents and analyzes the diversity of uses of ferns species reported by the inhabitants of Alto Atrato, Chocó, Colombia.

Methods: Semi-structured interviews were conducted with 17 local experts from the Alto Atrato community. Additionally, botanical walks were carried out to collect ferns specimens, which were subsequently identified and deposited at the Herbarium of the University of Antioquia (HUA). The uses reported by the experts were classified according to the categories proposed by Cook, and the Cultural Importance Index (CI) and Relative Frequency of Citation (RFC) were calculated.

Results: A total of 17 ferns species were reported with traditional uses. The species *Pityrogramma calomelanos* exhibited the highest CI (1.294), followed by *Cyathea trichiata* (0.706). Regarding RFC, *C. trichiata* and *P. calomelanos* shared the highest value (0.706). The most frequent use category was medicinal, accounting for 64.7% of the records.

Conclusion: There is a notable diversity of useful ferns species compared to the total number reported in the other surveys. Have been reported 13 new ethnopteridological species for Colombia. Additionally, an intergenerational gap in ethnobotanical knowledge was observed, underscoring the urgency of preserving this knowledge within the communities. *Pityrogramma calomelanos* holds significant cultural importance due to its diverse applications.

Keywords: Cyatheaceae, Ferns, medicinal, *Pityrogramma*, Use categories.

Resumen

Introducción: Los helechos son de gran utilidad para las comunidades aledañas, debido a su amplia diversidad de usos desde medicinales hasta mágico-religiosos. La población afrocolombiana cuenta con una rica tradición etnobotánica, lo que la convierte en un lugar ideal para explorar el conocimiento etnopteridológico. Este estudio documenta y analiza la diversidad de usos de las especies de helechos reportadas por los habitantes del Alto Atrato, Chocó, Colombia.

Métodos: Se realizaron entrevistas semiestructuradas con 17 conocedores de la comunidad del Alto Atrato. Complementariamente, se realizaron caminatas botánicas para la colecta de especímenes de helechos, los cuales fueron identificados y depositados en el Herbario de la Universidad de Antioquia (HUA). Los usos manifestados por los conocedores se agruparon en las categorías propuestas por Cook y se calcularon los índices de importancia cultural (IC) y frecuencia relativa de citación (FRC).

Resultados: Un total de 17 especies de helechos fueron reportados con algún uso tradicional. La especie *Pityrogramma calomelanos* presentó el mayor IC (1.294), seguida de *Cyathea trichiata* (0.706). En cuanto a la FRC, *C. trichiata* y *P. calomelanos* compartieron el valor más alto (0.706). La categoría de uso más frecuente fue medicinal, presente en el 64.7% de los registros.

Conclusión: Hay una notable diversidad de especies de helechos útiles, comparado con el número total reportado en otros estudios. Se reportan 13 especies etnopteridológicas nuevas para Colombia. Además, se observa una brecha en el conocimiento etnobotánico entre generaciones, destacando la necesidad de preservar este saber en las comunidades. *Pityrogramma calomelanos* es culturalmente importante por su diversidad de usos.

Palabras clave: Categorías de uso, Cyatheaceae, Helechos, medicinal, *Pityrogramma*

Background

The term ethnobotany was introduced into science by Harshberger (1896), who proposed that this discipline would help clarify the problem of plant distribution based on the different uses attributed by various tribes. According to Albuquerque *et al.* (2017), since then, there has been growing scientific interest in studying the interaction between humans and plants in their environment, emphasizing that ethnobotany should help us understand how an entire culture makes use of plants. The scope and definition of ethnobotany have continuously evolved. Initially, the field focused on documenting plant diversity and the uses reported by local communities (Balick 1996, Etkin 1988). However, contemporary ethnobotany seeks to understand how and why people select plants for a wide variety of purposes (Gaoue *et al.* 2017).

Monilophytes, commonly known as ferns, exhibit remarkable global diversity with 10,578 documented species (PPG I 2016), though they are particularly abundant in tropical regions (Moran 2017, Sanginés-Franco *et al.* 2015). Due to their exceptional diversity and ecological adaptability, these plants have held significant historical value across various cultures, serving as ornamental (Antony & Suresh 2022, Ranil & Bussmann 2021, Suraj *et al.* 2020), construction (Muñiz *et al.* 2007, Rendón-Aguilar *et al.* 2017), medicinal (Ranil & Bussmann 2021, Rendón-Aguilar *et al.* 2017, Scarpa & Cassá 2015), and magico-religious purposes (Keller *et al.* 2011, Keller & Prance 2015).

In the context of ornamental use, ferns are prized for their unique leaf shapes, coloration, and stem arrangements (Rendón-Aguilar *et al.* 2017). In construction, the stems of certain tree ferns have been used as posts or beams, while the rachis and petiole of other species have been utilized for crafting baskets and chair seats (Muñiz *et al.* 2007). The medicinal field represents the most extensively documented application of ferns, with numerous species found to contain bioactive compounds or secondary metabolites effective in treating various diseases (Ranil & Bussmann 2021). These compounds have demonstrated antioxidant, anticancer, and antimicrobial properties (Baskaran *et al.* 2018). However, despite the increase in ethnobotanical studies focused on these plants (Keller *et al.* 2011), ferns and their traditional uses in many regions, including Colombia, have been relatively under-researched.

Colombia is considered one of the most biodiverse countries in the world with approximately 1500 species of ferns (Murillo-Aldana & Murillo-Pulido 2017) due to its tropical location and the variety of ecosystems it hosts, and ethnobotanical studies focused on ferns are scarce. For instance, Murillo-Pulido (1983) made the first contribution on the properties and potential uses of this taxonomic group. Jiménez (2011) conducted an ethnobotanical review of this group, recording 87 species used for various purposes, particularly medicinal and environmental uses. Subsequently, Diazgranados (2022) conducted a

taxonomic summary of useful plants in Colombia, reporting the use of 178 species of ferns for specific purposes, and highlighting their medicinal, environmental, and material applications. This study is relevant as it provides an update on the number of useful fern species in the country. Despite the heterogeneity of the data sources, which are drawn from a variety of ethnobotanical studies, this analysis reflects the expanding research in this domain and offers a comprehensive overview of the potential applications of ferns within the country. In Bogotá, Rojas (2024) documented the use of 29 species of ferns, emphasizing their medicinal and ornamental applications. In the department of Chocó, in the Pacific coast, Estrada-Jiménez *et al.* (2019) recorded the therapeutic value of the species *Cyathea multiflora* Sm. There are general studies such as those by Cogollo-Calderón and García-Cossio (2012) and Rentería (2012) that documented specific uses of certain ferns species in this region including *Trichomanes elegans* Rich, *Cyathea lasiosora* (Mett. ex Kuhn) Domin, and *Tectaria vivipara* Jermy & T.G. Walker.

Chocó is regarded as one of the most biodiverse regions in Colombia (Bernal *et al.* 2016), and it is renowned for its rich cultural heritage (National Administrative Department of Statistics - DANE 2019). However, the region's rich biological and cultural diversity is under threat due to increasing anthropogenic activities, including mining, deforestation (Ramírez-Moreno & Ledezma-Rentería 2007), and even armed conflict (Arboleda-Castro 2024). These conditions further validate the need to conduct ethnobotanical studies to document the diversity of ferns and other plants in the Chocó region, considering that one of the main objectives of ethnobotany is the documentation of plant diversity and the uses that a given community gives them (Gaoue *et al.* 2017). Muthu *et al.* (2006) consider this aspect crucial for the preservation of traditional or local knowledge over time; furthermore, these studies are of vital importance for conservation processes (Albuquerque *et al.* 2009, Muthu *et al.* 2006, Pei *et al.* 2020). Additionally, these anthropogenic activities have a direct impact on the inhabitants and their local knowledge, threatening the ancestral heritage of the Afro-descendant, indigenous, and peasant communities that inhabit the territory

According to DANE (2019), a significant proportion of adults in Afro-Colombian territories are illiterate. This phenomenon is particularly disconcerting, as cultural and ethnobotanical heritage has traditionally been preserved through the oral transmission of knowledge. Consequently, this practice has resulted in the gradual erosion of these traditions, leading to a progressive loss of ancestral knowledge (Puyo 2018). Schultes and Raffauf (1990) posited that certain cultures prioritize the preservation of their knowledge by meticulously documenting the applications of species in herbalism. Conversely, the Ministry of Environment and Sustainable Development (MADS 1998) asserts that the herbal knowledge of numerous communities in the Colombian Pacific is entrusted in the hands of knowledgeable individuals who transmit it through oral tradition. Martínez (2023) posits that this phenomenon occurs in Chocó, which underscore the necessity for ongoing exploration of the region's flora, with a particular focus on the ferns occurring in this area. To contribute to the documentation and analysis of the uses of ferns in the Chocó region, this study aims to analyze the diversity of ethnobotanical uses of this group of plants reported by the communities living in the municipality of Bagadó, Chocó.

Materials and Methods

Study area

The department of Chocó, in the Colombian Pacific Coast, is in the far west of the country. Within Chocó, the Atrato subregion stands out as one of the ecoregions with the highest rainfall on the planet, particularly the Alto Atrato area (Castaño 2021). This region is a geographical block or collective territory located in the central-eastern part of the department of Chocó, on the western flank of the Western Cordillera of the Andes. It falls under the jurisdiction of the Community Council of the Popular and Peasant Organization of Alto Atrato (COCOMOPOCA, by its Spanish acronym) (Castaño 2021).

The study was performed at the community of Bagadó, which is located in the Alto Atrato region and is part of a tropical rainforest biome (Holdridge 1987), in the eastern end of the department of Chocó, specifically on the left bank of the Andágueda River at coordinates 05° 24’ 32” N and 76° 25’16” W, at an elevation of 200 m a.s.l (Figure 1). The topography of the area consists of steep hills that drain the river basins, and although the forest has been affected by anthropogenic activities such as mining and logging, it has well preserved areas that have been declared protected by the communities (Castaño 2021). Additionally, research also was conducted in the rural communities of El Salto (5°23'43.05" N, 76°20'20.09" W), Muchichí (5°24'10.19" N, 76°21'14.29" W), and La Sierra (5°24'6.13" N, 76°21'30.29" W) (Figure 1). These zones were selected due to the following: 1) the affinity of ferns to humid environments, 2) population access to forest resources, and 3) the access to these communities. Additionally, prioritizing the edges of streams, forests with little or no intervention and roadsides, and these locations were selected based on the biology and ecology of the ferns group, which is known to be abundant in such environments (Della 2022, Della & Falkenberg 2019).

According to municipal population projections by area and ethno-racial affiliation from DANE (https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/proyecciones-de-poblacion), Bagadó is projected to have 11,959 inhabitants in 2025, comprising 8,029 Indigenous persons and 3,868 Afro-descendants. The remaining population includes Palenquero, Raizal, or non-ethnic-racial groups. The urban population (the focal area of this study) includes 2,309 inhabitants, with 121 identifying as Indigenous and 2,174 as Afro-descendant. The total population includes 5,962 males and 5,997 females.

Traditionally, this population has maintained agricultural and mining livelihoods, however, while mining activity has remained stable over time, it has induced transformations in both aquatic and terrestrial ecosystems. Notably, mining has become the primary economic activity for most residents (Concejo Municipal de Bagadó 2008).

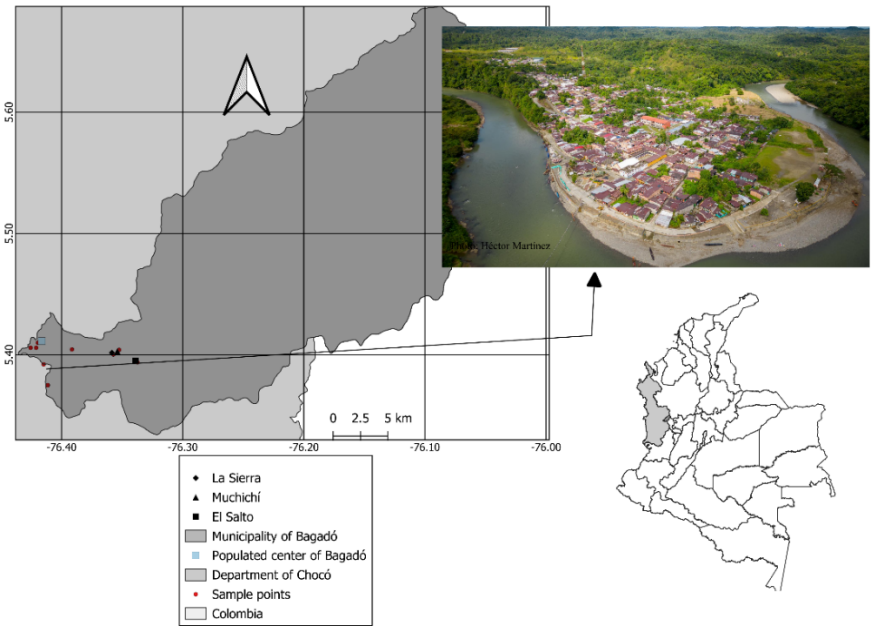

Figure 1. Geographical location of Bagadó municipality, Alto Atrato, Chocó, Colombia. The light gray area represents Chocó department. The dark gray area indicates the study zone, the blue rectangle marks the urban center (municipal capital), red and black dots show sampling locations and rural communities respectively.

Collection and identification of plant material

The collection was carried out in accordance with the provisions outlined in the framework permit no. 0524 and the 001566 of the University of Antioquia, given by the National Environmental Licensing Authority (ANLA).

The ferns specimens were collected in different areas of the municipality of Bagadó. After the collection of specimens, identification was conducted through comparison with relevant reference materials and deposited in the Herbarium of the University of Antioquia (HUA). The determination process was further validated through consultations with specialized experts and a thorough review of relevant databases, including: The National Herbarium of Colombia (COL) (http://www.biovirtual.unal.edu.co), Pteridoportal (https://pteridoportal.org/portal/index.php) and Jstor (https://www.jstor.org/) was consulted for comparison with the types. Finally, the botanical names were adapted according to the proposals of PPG I (2016) and The International Plants Name Index (http://www.ipni.org/). Furthermore, species were described according to Lellinger (2002), with the monographaR package utilized for this purpose (Reginato 2016). The paper was composed using Quarto (Allaire *et al.* 2022) under the RStudio software interface (RStudio Team 2020).

Ethnobotanical data collection

To document the uses that local communities attribute to ferns species, 17 local knowledge holders were interviewed (Table 1). These local knowledge holders were selected using the snowball method (Goodman 1961), meaning that inhabitants of the municipality identified them as plant experts, and these experts, in turn, recommended other knowledgeable individuals. Once the local knowledge holders were identified, semi-structured interviews were conducted, following the methodology proposed by Martin (1995) (Annex 1).

Table 1. Sociodemographic data of the local knowledge holders from the municipality of Bagadó, Alto Atrato, Chocó.

Variables	Categories	No. of individuals	Percentage (%)	Variables	Categories
Local experts	Man	10	58.82%	Local experts	Man
	Female	7	41.18%		Female
Age	<40	2	11.76%	Age	<40
	41-60	4	23.53%		41-60
	60>	11	64.71%		60>
Occupation	Miner	11	64.71%	Occupation	Miner
	Farmer	4	23.53%		Farmer
	Housewives	2	11.76%		Housewives
Education	With studies	13	76.47%	Education	With studies

Although use categories were predefined, knowledge holders were asked open-ended questions to avoid biasing or limiting their responses. Reported uses were subsequently classified according to Cook's (1995) standardized categories (Table 2). During these sessions, local knowledge holders were asked about the uses they assign to ferns, the specific plant parts utilized, moreover, were registered the growth habits, and the types of habitats where these plants grow. Additionally, photographic images taken during field walks were shown to the local knowledge holders, and live plant samples were brought to those who could not easily access the forest (Figure 2). Both the interviews conducted during the walks and the image projections were performed individually to ensure the independence and reliability of the data.

Field expeditions were carried out in January and June 2024, with four trips per season (eight in total). Each expedition involved approximately six hours of sampling effort. The number of outings was constrained by logistical challenges, including public safety conditions, guide/participant availability, and accessibility to rural settlements.

Each participant provided signed informed consent, ensuring data authenticity and permission for photograph usage. As noted earlier, documented uses were systematically classified following Cook (1995), aligning with the author's effort to standardize descriptors in ethnobotanical studies. This framework originates from the International Working Group on Taxonomic Databases for Plant Sciences (TDWG 1992, cited by Cook 1995).

Table 2. Cook's use categories with their respective description or application in this study

Cook's use categories.	Descriptions
Medicinal	Plants employed for curative properties (e.g., treating diarrhea, fever, snakebite envenomation).
Fuel	Ferns utilized as biofuel or combustible material.
Cultural	Species with magic-religious or spiritual applications.
Environmental	Includes fertilizers, ornamentals, or erosion control.
Food	Species used in food preparation for humans or animals.
Chemical	Species used for cosmetic purposes or to derive chemical products.
Fiber	Plants processed into ropes, threads, textiles, or baskets.
Construction	Plants used as timber, building materials, or tools.
Other	Subcategories like research, genetic resources, or agroforestry.

Data Analysis

Data were analyzed in RStudio (RStudio Team 2020) using the "ethnobotanyR" package of Whitney (2022). The following indices were calculated:

Cultural Importance Index (CI)

To assess the significance of plant species used by the communities, we employed the Cultural Importance Index (CI) described by Tardío and Pardo-de-Santayana (2008). This index helped identify key plant species in local culture and reflected their importance to knowledge holders. The index was calculated using the following formula:

$$CI_S = \sum_{u=u_1}^{u\,NC} \sum_{i=i_1}^{i\,N} UR_{ui/N}$$

Relative Frequency of Citation Index (RFC)

This index considers the popularity of a species among knowledge holders, enabling the identification of the most valued and potentially useful plants in the community (Tardío & Pardo-de-Santayana 2008).

$$RFC_S = \frac{FC_S}{N} = \frac{\sum_{i=i_1}^{i\,N} UR_i}{N}$$

Figure 2. Botanical walks with plant experts from the municipality of Bagadó, Alto Atrato, Chocó.

Following the classification of uses into distinct categories, the demographic data of the knowledgeable was meticulously organized according to gender, age, occupation, educational level, and the collection and transmission of ethnopteridological knowledge. This included both those who acquired this knowledge and those who imparted it. This process enabled the calculation of the distribution percentages for each variable.

Results

Demographic characteristics of local knowledge holders

Among the 17 traditional knowledge holders interviewed, 23.53% (n=4) had not begun or completed primary education (classified as “no formal schooling”), while the remaining 76.47% (n=13) had completed at least primary education (classified as “with schooling”). Regarding botanical knowledge, men represented a higher proportion (58.82%) of experts than women (41.18%). Elderly individuals (aged >60 years) comprised approximately 64.71% of respondents, which participants attributed to declining interest among younger generations in maintaining botanical traditions. Mining and agriculture were the primary occupations reported, with a smaller percentage engaged in homemaking (Table 1).

The study revealed distinct patterns in knowledge transmission: 41.2% of respondents acquired ethnopteridological knowledge exclusively from grandparents, while 29.4% learned from both grandparents and parents or from parents alone (Figure 3A). Notably, 64.7% reported not having transmitted this knowledge to others, 17.6% had shared it with siblings, 11.8% with their children, and 5.9% with other recipients, particularly spouses (Figure 3B).

Diversity of useful ferns

During botanical field surveys conducted with local knowledge holders, we documented 17 ferns species with traditional uses, representing 10 genera and seven families (Table 3). *Pityrogramma calomelanos* was the most frequently cited species (22 use reports), followed by *Cyathea trichiata* (12 reports). At the genus level, *Cyathea* (five species), *Nephrolepis* (three

species), and *Sticherus* (two species) showed the highest species richness, while remaining genera were represented by single species. Among families, Cyatheaceae was most diverse (six species), followed by Gleicheniaceae and Nephrolepidaceae (three species each), with other families represented by one-two species (Table 3). Representative specimens are illustrated in Figure 4.

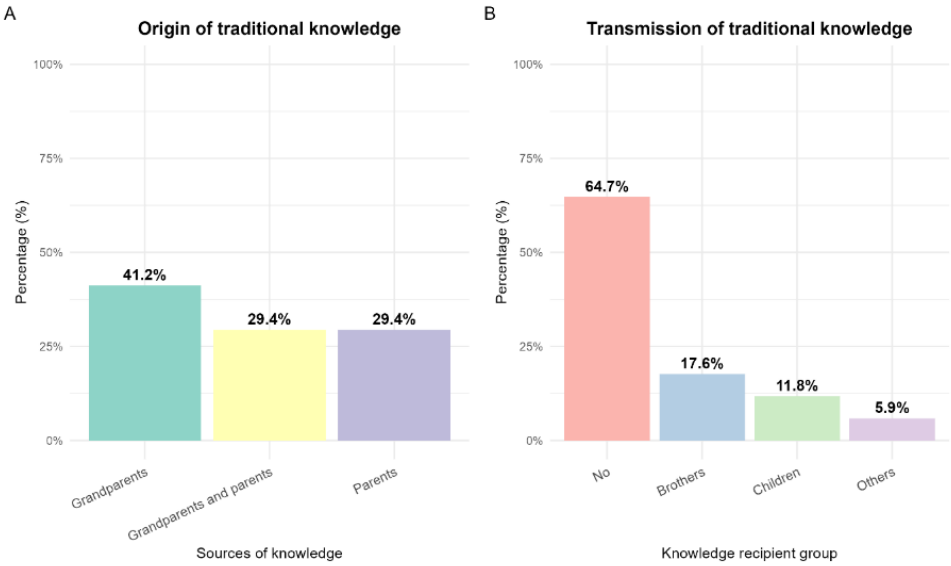

Figure 3. Source and transmission of ethnopteridological knowledge in the municipality of Bagadó. A = the people from whom the experts acquired the knowledge. B = the people to whom the experts have transmitted their ethnopteridological knowledge.

Figure 4. Photographs of some of the fern's species with some reported use by knowledge holders from the municipality of Bagadó, Alto Atrato, Chocó. A = *Nephrolepis falcata*. B = *Salpichlaena volubilis*. C = *Cyathea decorata*. D = *Pityrogramma calomelanos*. E = *Cyathea spectabilis*. F = *Meniscium falcatum*.

Description of useful species

Blechnaceae

Salpichlaena volubilis (Kaulf.) J. Sm.

Terrestrial fern. Compact rhizome, scales dark brown to blackish, basipeltate, with entire margins. Climbing fronds. Laminae pinnate, fertile pinnules narrower than sterile, conform. Pinnae linear elliptic to linear lanceolate, bases asymmetric, margin entire, apex acuminate to attenuate; scales abaxially costae present, light brown to yellowish, deciduous, basipeltate. Veins simple or proximal, once bifurcate. Sori linear is paired on commissural veins parallel to costa.

Traditional use: Used as a fiber to tie different objects or materials.

Cyatheaceae

Alsophila cuspidata (Kunze) D.S. Conant

Arborescent, up to 10 m long and 10 cm in diameter. Rhizome with spines dark, rigid. Petiole dark brown, with large spines; scales yellowish brown, lanceolate, with apical setae. Laminae bipinnate, pinnatifid, subconforming. Pinnae alternate, sessile or shortly pedicellate. Veins free. Sori round, costal or subcostal. Indusium cyatheoid.

Traditional use: The decoction is prepared as a common medicinal beverage for fever treatment. Practitioners place parts of the defoliated crown in approximately one liter of water. Once the mucilage has partially released into the infusion, the water is consumed. Knowledge holders emphasize the necessity of changing the water after several days of use. This standardized preparation method applies to all arborescent fern species.

Cyathea brunnescens (Barrington) R.C. Moran

Arborescent, 1.5-6 m long and 6-13 cm in diameter. Petiole dark brown, with short-circinate spines; scales denticulate, brown to dark brown, concolorous. Laminae bipinnate, pinnatisect, nonconforming. Pinnae alternate, sessile or shortly pedicellate. Rachis dark brown, lustrous, with short-circinate spines and trichomes. Veins free or furcate. Sori rounded, subcostal or supramedial. Exindusiated.

Traditional use: Used as an ordinary drink, to treat fever.

Cyathea decorata (Maxon) R.M. Tryon

Arborescent, up to 5 m long and 13 cm in diameter. Petiole brownish, densely pubescent; scales ochre-white, concolorous to bicolored. Laminae pinnate, pinnatifid, nonconforming. Pinnae markedly alternate above petiole base, sessile or shortly pedicellate, lobes entire, apex acuminate. Rachis and costae greenish brown, densely pubescent. Veins bifurcate in the middle. Sori round, medial. Indusium hemiteloid.

Traditional use: Used as an ordinary drink, to treat fever.

Cyathea spectabilis (Kunze) Domin.

Subarborescent, up to 0.5 m long and 5 cm in diameter. Petiole straw-colored, with spines towards base; scales bicolored, lanceolate. Laminae pinnate, pinnatifid, conform. Pinnae opposite, sessile, basal segments often overlapping rachis, lobes serrate, apex acuminate. Rachis exalate, glabrous. Costae sometimes abaxially scaly. Veins simple to 3-bifurcate, basal veins anastomosed, forming costal areoles. Median sori. Exindusiate.

Traditional use: The frond lamina is crushed and aqueous-extracted for oral administration in diarrhea treatment.

Cyathea sp.

Arborescent up to 3 m long and 13 cm in diameter. Petiole dark brown, lustrous, sparsely spiny; scales, denticulate, brown to brownish-yellow, concolorous, fibrillose, denticulate. Laminae bipinnate, pinnatisect, nonconforming. Pinnae alternate. Pinnules shortly pedicellate, sessile distally, margin crenulate, apex obtuse to broadly acute. Rachis brown to purplish brown. Veins furcate. Sori rounded, medial, arising from furcate vein. Exindusiate.

Traditional use: Used as an ordinary drink, to treat fever.

Cyathea trichiata (Maxon) Domin

Arborescent, up to 10 m long and 10 cm in diameter. Petiole straw to yellowish-brown, with short spines; scales bicolored, with dark center and white margin, fibrillose, with marginal black setae. Laminae bipinnate, pinnatifid, nonconforming. Pinnae alternate, sessile or with short pedicel. Rachis straw-colored, spiny. Furcate veins. Medial sori. Exindusiate.

Traditional use: Used as an ordinary drink, to treat fever.

Gleicheniaceae

Gleichenella pectinata (Willd.) Ching.

Terrestrial fern. Rhizome long creeping, with red to brown hairs. Petiole brown to brown. Laminae 1-4 bifurcate, ultimate branches linear to lanceolate. Pinnae of last abaxial surface segments with red stellate hairs, adaxial surface glabrous, base attenuate, margins entire, apex pinnatifid. Rachis and costae greenish yellow, glabrous. Dormant buds on furcations pubescent with red hairs. Veins 2-3 forked. Sori rounded. Exindusiate.
Traditional use: Used as dendroenergetic to stimulate fire intensity.

Sticherus bifidus (Willd.) Ching.
Terrestrial fern. Rhizome long creeping, triangularly scaled, dark brown. Petiole straw to brownish. Laminae 2-3 bifurcate, ultimate branches lanceolate with pinnatifid apex. Pinnae on last segments linear, abaxial surface moderately covered with arachnoid scales on lamina tissue and veins, base reduced, margins flat or slightly revolute, apex gradually reduced. Dormant buds on furcations with triangular scales, brown with central darkening and fimbriate margins. Veins 1-bifurcate. Sori rounded. Exindusiate.
Traditional use: Used as a dendroenergetic to stimulate fire intensity.

Sticherus chocoensis J. Gonzales
Terrestrial fern. Rhizome long creeping, with bicolor scales, brown in the center and clear margins. Petiole dark brown. Laminae 2-3 furcate, ultimate branches lanceolate, pectinate, pinnatisect. Pinnae on last inner segments, abaxial surface orange, base reduced, margins entire, apex gradually reduced. Dormant buds on furcations with aphlebia present. Veins parallel. Inframedial sori. Exindusiate.
Traditional use: Used as a dendroenergetic to stimulate fire intensity.

Nephrolepidaceae
Nephrolepis cf *brownii* (Desv.) Hovenkamp and Miyam. Grass.
Rhizome suberect, with stolons usually stilt-forming; scales on stolons sparse, adpressed or spreading. Tubercles absent. Petiole brown to light brown. Laminae pinnate, mid pinnae straight or slightly falcate. Pinnae opposite, base truncate, margins serrate or crenulate, apex acute. Rachis brown to light brown, with scales. Veins simple. Sorus round, marginal or submarginal. Reniform indusium.
Traditional use: Used as an ornament.

Nephrolepis biserrata (Sw.) Schott
Terrestrial fern. Rhizome suberect, with scales on stolons very sparse to dense. Tubercles absent. Petiole black. Laminae pinnate, mid pinnae straight or slightly falcate. Pinnae alternate, base truncate, margin crenulate or serrate and towards apex serrate, apex acuminate. Rachis and costae with sparse hairs. Veins bifurcate. Sori round, dark brown. Reniform indusium.
Traditional use: Used to treat some diseases

Nephrolepis falcata (Cav.) C. Chr.
Terrestrial fern. Rhizome suberect, with scales on stolons, adpressed. Tubercles absent. Petiole brown. Laminae pinnate, mid pinnae marked to strongly falcate, fishtail-shaped. Pinnae alternate, base truncate, margin dentate or serrate, apex acute. Rachis with black scales. Veins anastomosed. Sori round, light brown. Indusium reniform.
Traditional use: Used as an ornament.

Pteridaceae
Pityrogramma calomelanos (L.) Link
Terrestrial fern. Rhizome suberect. Petiole black to atropurpure, glabrous. Laminae bipinnate, pinnatifid, nonconforming. Pinnae equilateral, shortly pedicellate, margin serrate, apex abruptly reduced. Pinnules covered with white to cream farina on underside, margin serrate or entire. Rachis and costae black, glabrous. Veins pinnate, veins originating on costa. Exindusiate.
Traditional use: The rachis is utilized for its fiber content, employed for fish farming, as a treatment for diarrhea, and as a component of magical and religious practices. The latter refers to the belief that, from the wake until the final novena of a deceased person, where fragments of the plant or the entire plant are immersed in a container of water. This practice is believed to ensure that the soul of the deceased is hydrated and at peace. Furthermore, individuals afflicted with Parkinson's disease or experiencing heightened emotional states have reported a marked reduction in anxiety when consuming this water, which functions as a calming agent.

Adiantum tetraphyllum Humb. and Bonpl. ex Willd.
Terrestrial fern. Rhizome suberect with brown, fibrillose scales. Petiole black to atropurpure, sparsely scaly. Laminae bipinnate, conform. Pinnae alternate, lanceolate, shortly pedicellate, margin dentate, apex abruptly reduced, pinnatifid. Pinnules dimidiate, serrate. Rachis and costae black to atropurpure, densely scaly, the scales brown. Veins arising from base of pinnules, free, dividing towards margin. False indusium.
Traditional use: It is one of the species used to build the crown of the dead.

Tectariaceae
Tectaria mexicana (Fée) C.V. Morton
Terrestrial fern. Rhizome decumbent or erect. Petiole brown. Laminae bipinnate, pectinate, apex abruptly reduced. Pinnae alternate, proximal pinnae free and distinctly pinnatifid, middle pinnae distinctly pinnatisect, shortly pedicellate, margin entire to slightly serrate, apex acuminate. Rachis winged distally, yellowish brown. Veins anastomosed. Indusium reniform to circular.
Traditional use: Used to treat menstrual cramps.

Thelypteridaceae
Meniscium falcatum Liebm.
Terrestrial fern. Rhizome shortly creeping to suberect. Petiole blackish. Laminae pinnate, conform. Pinnae elliptic, base cuneate, margins entire to undulate or crenulate. Rachis and costae green, with trichomes or sometimes glabrous. Veins anastomosed, forming areoles of similar length. Sori lunate or elongate. Exindusiate.
Traditional use: Used to treat or counteract snake poison.

Categories of use
The analysis revealed distinct utilization trends among the documented species. The medicinal category predominated, encompassing 10 species with therapeutic applications, followed by fuel and cultural uses (three species each). Notably, the morphological similarity between Cyatheaceae species has led local communities to employ them interchangeably for analogous purposes. Something similar occurs with Gleicheniaceae species. *Pityrogramma calomelanos* emerged as exceptionally versatile, with reported applications spanning: Medicinal (therapeutic uses), fiber production (material applications), and cultural practices (ritual/ceremonial functions) (Figure 5).

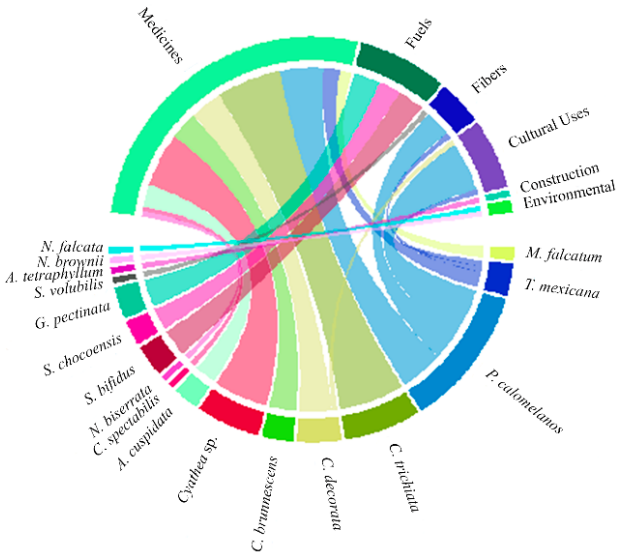

Figure 5. Uses applied to ferns species reported by plant experts in the municipality of Bagadó, Alto Atrato, Chocó.

Cultural Importance

Pityrogramma calomelanos demonstrated the highest CI value of 1.294, attributable to the diverse applications aforementioned. In contrast, *Cyathea trichiata* exhibited the second-highest CI value of 0.706, while *Adiantum tetraphyllum*, *Cyathea spectabilis*, *Nephrolepis biserrata*, *N. brownii*, *N. falcata*, and *Salpichlaena volubilis* each had only a single report, resulting in the lowest CI value of 0.059 for each species (Table 3).

Relative Citation Frequency

The species *Cyathea trichiata* and *P. calomelanos* recorded the highest FRC value (0.706), followed by *Cyathea* sp. with 0.588 and *C. decorata* with 0.412. Conversely, the species *A. tetraphyllum*, *C. spectabilis*, *N. biserrata*, *N. brownii*, *N. falcata*, and *Salpichlaena volubilis* exhibited an identical FRC value of 0.059, representing the lowest observed value (Table 3).

Plant parts used

The most frequently cited parts of the plant among local knowledge holders were the crown (49.3%) and the entire plant (40%). The remaining parts registered a utilization percentage of less than 6%, as illustrated in figure 6.

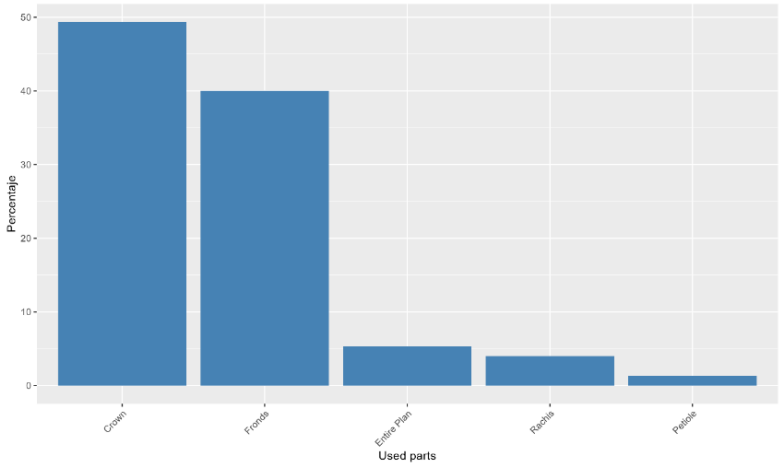

Figure 6. Parts of ferns used by plant knowledgeable people in the municipality of Bagadó, Alto Atrato, Chocó.

Discussion

Demographic characteristics of local knowledge holders

According to Duque (2008), the predominance of male experts over female experts with respect to plant knowledge could be related to gender roles established in the local culture, such as agricultural and mining activities. Conversely, the paucity of young interviewees may be attributable to the perception among connoisseurs that younger generations lack a sufficient degree of interest in the subject matter to facilitate knowledge transfer. This phenomenon could be indicative of an intergenerational transmission of ethnobotanical knowledge that has been repressed, which might lead to a diminution in the continuity of these practices. Pasquini *et al*. (2018) evidenced a similar case in three Afro-descendant communities in the Bolivar department of the Colombian Caribbean region. It was observed that the preservation of ancestral knowledge was entrusted to a limited number of individuals, thereby contributing to the gradual decline of these traditional practices. In Brazil, Moura and Diniz (2025) also reported that the traditional knowledge of the Arara indigenous community was not being transmitted, possibly due to the prolonged time spent by children in school.

According to Turner *et al.* (2011), the absence of young connoisseurs underscores the imperative for the implementation of strategies aimed at facilitating the transmission of knowledge to subsequent generations, thereby ensuring the continuity of traditional knowledge in the face of its potential extinction. Despite the retention of this knowledge among elders, the gradual erosion of traditional knowledge of ferns can be attributed to rapid cultural change, accelerated by multiple and complex cultural and socio-economic factors. These factors, as elucidated by Saynes-Vásquez *et al.* (2016) and Álvarez-Salas *et al.* (2016), contribute to the erosions of the transmission of local knowledge, practices, and visions to subsequent generations. However, García *et al.* (2024) indicate that, from the perspective of elders, becoming sages serves to preserve their cosmology, customs, and territory, thereby reinforcing their cultural identity and practices. This phenomenon can be interpreted as a manifestation of cultural and social rootedness, which reinforces the sense of belonging to their community.

Table 3. List of monilophyte species used by knowledge holders from the municipality of Bagadó, Alto Atrato, Chocó.

Family	Scientific name / Voucher	Collector and collection number.	Common names	Growth forms	Habitat	Status	Conservation status	Used parts	RCF	CI
Pteridaceae	*Pityrogramma calomelanos* / HUA - 240840	Pérez-Mosquera JF. 38	Ensarta micuo, destramado or abre camino	G	La	N	NE	Fronds	0.71	1.29
Cyatheaceae	*Cyathea trichiata** / HUA - 240723	Pérez-Mosquera JF. 3	Tasí hembra	A	Sf	N	LC	Crown	0.71	0.71
Cyatheaceae	*Cyathea* sp.* / HUA - 240833	Pérez-Mosquera JF. 28	Tasí macho	A	Sf	N	LC	Crown	0.59	0.59
Cyatheaceae	*Cyathea decorata** / HUA - 240825	Pérez-Mosquera JF. 1	Tasí macho	A	Sf	E	LC	Crown	0.41	0.41
Cyatheaceae	*Cyathea brunnescens** / HUA - 240722	Pérez-Mosquera JF. 2	Tasí macho	A	Sf	N	LC	Crown	0.29	0.29
Gleicheniaceae	*Gleichenella pectinata* / HUA - 240504	Pérez-Mosquera JF. 6	Helecho, pela puerco, Buruburaca or Sinapai	G	La	N	NE	Fronds	0.29	0.29
Gleicheniaceae	*Sticherus bifidus** / HUA - 240724	Pérez-Mosquera JF. 5	Helecho, pela puerco, Buruburaca or Sinapai	G	La	N	NE	Fronds	0.29	0.29
Tectariaceae	*Tectaria mexicana** / HUA - 240640	Pérez-Mosquera JF. 29	Salvagina	G	Er	N	NE	Fronds	0.18	0.29
Cyatheaceae	*Alsophila cuspidata* / HUA - 240841	Pérez-Mosquera JF. 40	Tasí hembra	A	Sf	N	LC	Crown	0.23	0.23
Gleicheniaceae	*Sticherus chocoensis** / HUA - 240978	Pérez-Mosquera JF. 15	Helecho, pela puerco, Buruburaca or Sinapai	G	La	N	NE	Fronds	0.23	0.23
Thelypteridaceae	*Meniscium falcatum** / HUA - 240844	Pérez-Mosquera JF. 42	NN	S	La	N	NE	Fronds	0.12	0.12

Family	Scientific name / Voucher	Collector and collection number.	Common names	Growth forms	Habitat	Status	Conservation status	Used parts	RCF	CI
Pteridaceae	*Adiantum tetraphyllum* / HUA - 240837	Pérez-Mosquera JF. 35	NN	G	Er			Fronds	0.06	0.06
Cyatheaceae	*Cyathea spectabilis** / HUA - 240739	Pérez-Mosquera JF. 32	NN	S	R	N	LC	Fronds	0.06	0.06
Nephrolepidaceae	*Nephrolepis biserrata** / HUA - 240830	Pérez-Mosquera JF. 20	Cacaito de orilla	G	R	N	NE	Fronds	0.06	0.06
Nephrolepidaceae	*Nephrolepis* cf. *brownii** / HUA - 240843	Pérez-Mosquera JF. 41	NN	G		Na	NE	Complete plant	0.06	0.06
Nephrolepidaceae	*Nephrolepis falcata** / HUA - 240743	Pérez-Mosquera JF. 39	NN	G		I	NE	Complete plant	0.06	0.06
Blechnaceae	*Salpichlaena volubilis** / HUA - 240639	Pérez-Mosquera JF. 26	Enredadera	C	Sf	N	NE	Rachis	0.06	0.06

Legend:
Common names: NN = Not reported. Growth forms: G = Grass, A = Arborescent, S = Subshrub, C= Climbing vine. Habitat: La= Logged-over areas, Sf = Secondary Forest, Er = Edges of ravines, R = Roadside. Status: N = Native, E = Endemic, Na = Naturalized, I = Introduced. Conservation status: LC = Least Concern, NE = Not Evaluated. Indexes: Relative Citation Frequency (RCF), Cultural Importance (CI). Asterisks (*) indicate species with new ethnopteridological reports.

Therefore, the comprehension of the distribution of traditional and local knowledge among the Afro-descendant communities in Colombia underscores the necessity to persist in the documentation of the utilization of these botanical resources. Moreover, the implementation of educational initiatives that incorporate the general population is imperative to ensure the preservation and revitalization of traditional knowledge.

Diversity of useful ferns

This study identified 17 species of ferns with some use described by plant connoisseurs only in the municipality of Bagadó. A comparison with the data of Diazgranados (2022) reveals that they represent 9.55% of the useful ferns in the country. According to the data of Murillo-Aldana and Murillo-Pulido (2017), they express 1.17% and 3.4% of the total fern species in the country and the department of Chocó, respectively. However, according to data from Cuesta-Nagles (2020), the number of genera and families recorded in this study represent 23.08% and 33.33% of the fern's diversity reported for the central eastern zone of the department of Chocó. The data obtained in the present study suggest that the inhabitants of the municipality of Bagadó utilize a considerable diversity of the ferns occurring in this geographic zone of the department of Chocó. These findings are comparable with those of Carbonó-Delahoz and Dib-Diazgranados (2013), who documented a total of 15 species, distributed in 11 genera and eight families of ferns used by the indigenous community Los Cogui in the Sierra Nevada de Santa Marta, Colombia. In turn, Rojas (2024) recorded 29 species distributed in 24 genera and 15 families, some of which have commercial value in the markets of Bogotá. The studies highlighted various applications, including ornamental, medicinal, construction, and environmental uses, underscoring the potential of this group of plants (Muñiz *et al.* 2007). Accordingly, it can be posited that ferns possess a substantial cultural and functional value, analogous to their utilization in other regions of the country which raises the need to carry out further research to understand the uses and possible applications given to this type of plants and thereby propose strategies for the conservation of knowledge and taxa. This traditional knowledge is not only crucial for science; it is also integral to the cultural identity of the communities in which it is found.

Categories of use

In accordance with the categories established by Cook (1995), the uses mentioned by local experts were medicinal, fuel, fiber, cultural uses, construction and environmental. These finding are consistent with those reported in other studies conducted in Latin America, for example, in Colombia (Diazgranados 2022, Rojas 2024), Honduras (Hernández-Cibrián 2007), México (Muñiz *et al.* 2007, Rendón-Aguilar *et al.* 2017), Argentina (Keller *et al.* 2011, Scarpa & Cassá 2015).

According to the findings reported by some surveys, including the aforementioned, the primary applications of ferns in Colombia and worldwide encompass the domains of medicine, environmental sciences, and horticulture (de Medeiros *et al.* 2023, Diazgranados 2022, Jiménez 2011, Keller & Prance 2015, Macía 2004, Ranil & Bussmann 2021). This finding aligns with the results obtained in this study, which demonstrate the potential use of ferns. According to these results, it is also evident that these plants have a high medicinal value, of which 10 species are reported with this use to treat some diseases such as diarrhea and fever. This trend underscores the significance of ferns as a valuable therapeutic resource for the treatment of various diseases, given the presence of secondary metabolites such as terpenoids, alkaloids, phenylpropanoids (Goswami *et al.* 2016), and triterpenoids which possess antitumor, antioxidant, and anti-inflammatory properties, while flavonoids have anticancer properties (Van-Wyk 2015). However, its medicinal use remains comparatively negligible in relation to that of angiosperm species (Abraham & Thomas 2022). In Colombia, ferns represent the taxonomic group with the least reported ethnobotanical utility, constituting only 2.4% (178 spp) of the total useful species documented for the country by Diazgranados (2022). The above helps to elucidate the paradigm and the negative perception associated with the chemical composition of monilophytes. In addition, it calls for further phytochemical and ethnopharmacological studies and invites a critical reflection on the prevailing tendency in the scientific literature to generalize regarding the bioactive or toxicological properties of this group of plants without considering the interspecific variability, which could influence their efficacy or potential harm.

The medicinal uses reported by plant experts in the municipality of Bagadó are consistent with previous studies conducted in different countries. For instance, *Pityrogramma calomelanos* has been documented as a remedy for stomach pains or gastric problems (Akomalafe & Sulaimon 2018, Jiménez 2011, Suraj *et al.* 2020), asthma, burns and blisters (Abraham & Thomas 2022), colds and fevers (Benjamin & Manickam 2007), and even for facilitating the smooth expulsion of the placenta after childbirth (Antony & Suresh 2022). *Cyathea* species here were cited for a similar use, specifically to treat fever and as an ordinary beverage, and these results are consistent with data obtained in the survey of Estrada-Jimenez *et al.* (2019) in Quibdó, Chocó, and in Brazil according to Reinaldo *et al.* (2015). Another similar finding that stands out from the

aforementioned applications of tree ferns is the utilization of mucilage from species such as *Cyathea caracasana* and *C. microdonta* to promote wound healing and prevent infections, respectively (Rojas 2024).

The findings of this study are somewhat surprising compared to the data obtained by Jiménez (2011), this is because 13 new ethnopteridological reports of species used in Colombia are presented: *Tectaria mexicana*, *Salpichlaena volubilis*, *Meniscium falcatum*, *Nephrolepis* spp, *Sticherus bifidus*, *Sticherus chocoensis*, *Cyathea spectabilis* and the remaining *Cyathea* spp. The latter include species as *Cyathea decorata*, *C. brunnescens* and *C. trichiata* because it is presumed that all Cyathea species with arboreal habit are used for a similar purpose since they are known by the same name "**Tasí**" in Chocó (Bernal 2017) and with different uses than *C. spectabilis*. The use of *Meniscium falcatum* as an antivenom is a novel report (Rentería 2012).

Cultural Importance Index (CI)

According to the Cultural Importance Index, ferns species reported by local experts are generally considered valuable by their communities. The CI estimate indicates that *Pityrogramma calomelanos* is the most valuable species, with a value of 1.294, which can be attributed to the multiple uses that the inhabitants of the Alto Atrato region attribute to this species. These uses include the procurement of fibers, the utilization of its medicinal properties, and its cultural applications. This finding aligns with studies that underscore the multifunctionality of specific ferns species within indigenous communities (Voeks 2004). In contrast, species such as *Adiantum tetraphyllum*, *Cyathea spectabilis*, and species of the genus *Nephrolepis*, which have a CI of 0.059, suggest a very limited or specialized use. For example, *A. tetraphyllum* is used exclusively for the construction of wreaths for the deceased, and *N. falcata* is used solely as an ornament. These variations in CI may be influenced by ecological availability and cultural specificity of each species, as has been documented in other regions (Berlin 1992). Furthermore, given the elevated CI values observed in species such as *P. calomelanos* and *C. trichiata*, these species could be classified as ethnospecies, a term denoting species with notable cultural significance. This categorization is in accordance with the prevailing biological classification and nomenclature systems established by Albuquerque *et al.* (2017). The comprehension of multifunctionality and specialization is imperative, as they facilitate the identification of species that play a pivotal role in the traditional practices of communities. This identification can subsequently inform conservation initiatives for species that are at risk, thereby fostering a comprehensive understanding of the ecological and cultural relationships associated with ferns.

As evidenced, the species of the genus *Cyathea* are utilized for analogous purposes due to their refreshing and curative effect. This phenomenon can be attributed to the minimal morphological differentiation observed among the species of this genus, which results in the assignment of identical names by communities. According to the widely accepted biological classification and nomenclature system revised by Albuquerque *et al.* (2017), this phenomenon can be attributed to the concept of ethnogenera, which refers to the aggregation of species within the same genus that exhibit similarities in terms of utilization and lifestyle. In the Chocó region, tree-like species of the genus *Cyathea* are presumed to be known as **tasí** (Bernal *et al.* 2017), and the findings of this study complement that information, since in Alto Atrato-Chocó both *Alsophila* and *Cyathea* species are also known as **tasí**, except *C. spectabilis*, being all employed as refreshing drinks and to treat fever. According to Berlin *et al.* (1973) and Berlin (1992), these groupings are established by communities to ensure the classification and organization of their natural world. Consequently, it is imperative to promote research that addresses taxonomy, ethnotaxonomy, and ethnopharmacology thereby better understanding the perception and codification practices of these communities. These studies could play a pivotal role in accurately delineating potentially medicinal species, given that popular names are designated based on morphological characteristics (Keller *et al.* 2011). This approach would prevent inaccuracies in future ethnopharmacological and related studies, considering their significant medicinal potential for the communities of Alto Atrato.

Relative Citation Frequency Index (RCF)

The citation values of the fern species denoted the importance that have for the communities of Bagadó municipality, for instance, *Cyathea trichiata* and *Pityrogramma calomelanos* obtained a CRF of 0.706, which confirms the high relevance that these species have for the community with respect to the other species of ferns found there. According to Tardío and Pardo-de-Santayana (2008), the most cited species are usually the most valued and used by the community. The significant disparity in the species with the highest value compared to those with the lowest FRC value (0.059) suggests a lower level of familiarity or utilization. For instance, species such as *Salpichlaena volubilis* and *C. spectabilis* were cited only once, as local knowledge holders indicated that they are utilized as a last resort when other plants are not available, such as for tying things up or treating diarrhea, respectively. This discrepancy may be indicative of ecological factors, such as species distribution and abundance, as well as socio-cultural aspects that influence the preference and utilization of certain plants (Phillips & Gentry 1993).

The high occurrence of species of *Cyathea* is likely to be a conspicuous element in the tropical forest, particularly in areas with few interventions, due to its architecture, size and frequency (Cárdenas *et al.* 2019), which renders them readily accessible to settlers. This phenomenon aligns with the availability hypothesis proposed by Voeks (2004) and Albuquerque (2006), who suggest that plants are mainly used in medicine due to their accessibility or local abundance. In this context, the primary applications of *Cyathea* species include the preparation of everyday beverages and the treatment of fevers. This frequent utilization underscores the profound influence of cultural and economic practices on the selection and utilization of specific plant species. According to Albuquerque and Ferreira-Júnior (2023), ethnobotanical studies must consider ecological and sociocultural factors to enhance our comprehension of plant-human interaction and promote the conservation and sustainable utilization of plants.

The values obtained for *Pityrogramma calomelanos* are attributed in part to the diversity of uses established by the community and mentioned by knowledgeable people as fiber, medicinal and cultural. According to the above, these results are similar to those of Suraj *et al.* (2020), who documented in the region of Kodagu in western India, the use of this species to treat various conditions such as kidney and gastric problems. For his part, Rojas (2024) recorded a similar case with species of the family Cyatheaceae, which had records of use in two or more categories, such as medicinal, ornamental and construction. The high citation of *P. calomelanos* and species of the genus *Cyathea* could be due to both the number of uses mentioned above and their wide geographical distribution, which makes them more accessible to villagers. These observations could also support the versatility hypothesis proposed by Alencar *et al.* (2010), which predicts that people are more likely to maintain knowledge, use and access to a plant that has many uses for humans. This is because they offer broader practical and symbolic value, which encourages their use and the transmission of associated knowledge.

Plant parts used

The investigation revealed that the crown and fronds were the most frequently employed plant parts, a finding that is according with the results reported by Jiménez (2011) and Rojas (2024). This could be attributed to the predominant medicinal application of ferns in the Alto Atrato region, a practice that has been repeatedly mentioned and is indicative of their therapeutic efficacy. For instance, the local population of Alto Atrato has a long-standing practice of harvesting the crowns of species belonging to the genus *Cyathea*, which they subsequently mix with water and consume as a regular beverage to rejuvenate or treat fevers. Marimuthu *et al.* (2023) underscored the ethnomedical significance of tree fern mucilage in healing injuries and its remarkable capacity to produce antimicrobial compounds. Conversely, the fronds of *Pityrogramma calomelanos* and *C. spectabilis* are utilized to manage diarrhea. Other authors such as Muhammad *et al.* (2020) have found that in general, the root and rhizome of ferns are most frequently used for medicinal purposes in different regions of the world, and Zambrano-Intriago *et al.* (2015) have stated that communities more frequently utilize leaves for medicinal purposes in different groups of plants. According to Maldonado *et al.* (2017), chemical compounds or secondary metabolites are predominantly concentrated in these organs, however, this may be contingent on the habitat, the developmental stage of the plant, and the method of preparation.

Conclusion

This study identified 13 novel ethnopteridological species not previously documented in Colombia. These species include *Tectaria mexicana*, *Salpichlaena volubilis*, *Meniscium falcatum*, *Nephrolepis* spp, *Sticherus bifidus*, *Sticherus chocoensis*, *Cyathea spectabilis* and remain *Cyathea* spp.

The use categories reported in this study included medicinal, fuel, fibers, cultural (encompassing magico-religious practices), construction, and environmental applications. Regarding cultural uses, a notable application involves *Pityrogramma calomelanos* in funeral wakes (velorios) and novenas (prayers for the deceased's soul) to ensure the departed soul remains hydrated and rests in peace. This specific usage is deeply rooted in the local tradition, as most plant experts mentioned it. Furthermore, they traditionally participate in these funeral rites and occasionally serve as rezanderos (individuals who lead prayers for the deceased). Concerning the use of *Cyathea* spp. as a common beverage (refreshing drink) or to treat fever, this practice is also widely recognized among local experts. Given that most are miners or farmers, these species are frequently utilized due to their broad distribution across the region.

The results of this study demonstrated a remarkable diversity of useful ferns species in relation to the total number of useful species of this taxonomic group in Colombia, with *Pityrogramma calomelanos* being particularly noteworthy due to its cultural importance, as reported by plant experts. This species stands out for its diverse applications, including its use as a source of fibers, as a medicinal agent, and in cultural practices. Although *C. trichiata* exhibited a higher level of prominence compared to other species of Cyatheaceae, the CRF of these species also underscores the significance of *Cyathea* spp. for

the communities of Alto Atrato. In summary, the high CRF values obtained for *P. calomelanos* and the species of the genus *Cyathea* might reflect how the interaction between abundance, accessibility, and variety of uses contributes to their cultural importance and continued use in the communities.

The local knowledge holders exhibit a lack of distinction between the morphologically similar *Cyathea* species, underscoring the necessity for interdisciplinary approaches, such as taxonomy, ethnotaxonomy, popular nomenclature, and phytochemistry, to elucidate the ethnospecies. This approach is imperative to avert potential inaccuracies in future ethnopharmacological and related studies, particularly given their significant medicinal potential for the communities of Alto Atrato.

Concerning the demographic characteristics of the local knowledge holders, evidence suggests a disjunction in ethnobotanical knowledge between older and younger people. Additionally, the predominance of men's ancestral knowledge over women's is highlighted, owing to the predominant activities they engage in. At the educational level, a greater ethnobotanical knowledge was observed among people with some level of education, constituting 76.47% of the total number of local knowledge holders. Furthermore, despite the limited number of experts interviewed, there is a paucity for the transmission of ethnobotanical knowledge, which jeopardizes the culture and ethnobotanical knowledge of the communities. As the plant experts noted, young people are not interested in learning. Therefore, the implementation of strategies that contribute to the conservation of this traditional knowledge is imperative, as well as to promote research and conservation of this group of plants, recognizing their cultural and environmental importance. This traditional knowledge is not only crucial for science; it is also integral to the cultural identity of the communities in which it is found.

Declarations

List of abbreviations: DANE: National Administrative Department of Statistics; HUA: Herbarium of the University of Antioquia; COL: National Herbarium of Colombia; COCOMOPOCA: Community Council of the Popular and Peasant Organization of Alto Atrato; CI: Cultural Importance; RFC: Relative Frequency of Citation; MADS: Ministry of Environment and Sustainable Development.
Ethics approval and consent to participate: An Ethic statement was prior shared with plant knowledge holders before gathering information for this research and all provided their prior informed consent before the interviews.
Consent for publication: Written consent was obtained from plant experts and the local community council.
Availability of data and materials: Voucher specimens have been deposited in the Herbarium of the University of Antioquia.
Competing interests: The authors declare no conflicts of interest.
Funding: This research received funding from the Ministry of Science, Technology and Innovation of Colombia (MinCiencias).
Author contributions: Jhon Freddys Pérez-Mosquera designed the methodology, conducted the fieldwork, and manuscript writing. Bladimir Vera-Marín contributed to the design of the methodology and manuscript writing. Mario Alberto Quijano-Abril and Fernando Alzate-Guarín participated in the study's conception, analysis, and manuscript writing.

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Annex 1. Ethnobotanical survey

ETHNOBOTANICAL SURVEY:
GENERAL INFORMATION ABOUT THE RESPONDENT

General background of the respondent

Name: _____
Community: _____
Age: _____
Gender: _____
Informant code: _____

Respondent's activity

Household chores		**Mining**		**Farmers**	
Healers		**Others:**			

Level of education

No education		**1st-3rd grade**		**4th-5th grade**	
6th-9th grade		**10th-11th grade**		**Technician - Technologist**	
Professional		**Postgraduate**			

Did you learn how to use these plants from anyone in particular?

Grandparents		**Brothers**		**Neighbors**		
Parents		**Friends**		**Others**		

Have you disseminated your knowledge of these plants to anyone else?

Children		**Brothers**		**Neighbors**		
Parents		**Friends**		**Others**		

ETHNOBOTANICAL SURVEY:
USE AND VALUATION OF MONILOPHYTES IN THE UPPER ATRATO, CHOCÓ

Date of collection: _____
Collection code: _____
Coordinates: _____
Location: _____
Informant code: _____

Common name of the plant				
Morphological description of the plant				
How do you recognize the plant?				
Which part of the plant do you use?				
What do you use this plant for?	**Food - Animals**		**Food - Human**	
	Chemicals		**Construction**	
	Medicinal use		**Fuel**	
	Fibers		**Cultural use**	
	Environmental		**Other**	