State of knowledge of bryology and ethnobryology in Ecuador: A systematic review for three decades (1990-2025)

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Research

Abstract

Background: Bryophytes are a highly diverse group, with approximately 23,000 species worldwide and about 1,650 species recorded in Ecuador, playing key roles in biodiversity, biomass, and ecosystem functioning. Bryology is the discipline that studies bryophytes, including ethnobryology, which focuses on the traditional uses of these organisms.

Methods: This study presents information on the use of bryophytes in Ecuador. A systematic review was conducted using local, regional, and global databases covering the period 1990-2025, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Results: A total of 107 articles were identified, of which 88 were indexed in global database (Scopus and Web of Science), one in SciELO, six in Latindex, two book chapters from Springer and eleven in other indexing databases. Number of articles did not follow a consistent pattern, with few studies in the early years and several years with no publications; however, from 2008 onward, the number of studies increased, ranging from two to peaks of nine publications per year. Most research focused on ecological topics, followed by taxonomic, phytochemical, and molecular studies, whereas no studies addressed ethnobryology. A total of 82 studies focused exclusively on bryophytes, 22 combined bryophytes and lichens, and three addressed biological soil crusts. Epiphytic bryophytes were the most frequently studied group (39 studies), followed by terricolous species (29 studies). For the first time in Ecuador, a list of 28 bryophyte species was compiled from an ethnobryological perspective.

Conclusions: Although bryological research has increased in recent years, fields such as ethnobryology, phytochemistry, molecular studies, and biological soil crust research remain underexplored and require further investigation. Thus, this study provides the first documented record in Ecuador of the uses of 28 bryophyte species.

Keywords: Ethnobryology; bryophytes; epiphytes; PRISMA; Scopus

Background

Globally, bryophyte diversity has been estimated at between 20,000 and 23,000 species (Bahuguna *et al.* 2013; Patiño & Vanderpoorten 2018; Novaković *et al.* 2021), of which approximately 12,500 species correspond to mosses (Crosby *et al.* 1999; Cox *et al.* 2010), 8,500 species to liverworts (Von Konrat *et al.* 2010; Söderström *et al.* 2016), and about 250 species to hornworts (Villarreal *et al.* 2010). Bryophytes play key roles in biodiversity, biomass production, and ecosystem functioning related with water and nutrient cycling (Gradstein 2008) and provide shelter and food for a wide range of insects, microorganisms, small reptiles, amphibians, and several bird species (Nadkarni & Matelson 1989; Smith *et al.* 2001; Benítez *et al.* 2023). Due to their poikilohydric nature, bryophytes are strongly dependent on external humidity and temperature conditions (Gradstein *et al.* 2001). Thus, they are sensitive to environmental changes and are widely used as model organisms to evaluate the impact of human activities such as deforestation (Nöske *et al.* 2008), air pollution (Benítez *et al.* 2021), and climatic change (Gignac 2001; Hespanhol *et al.* 2022).

In this context, bryology is a botanical discipline focused on the study of bryophytes, including mosses, liverworts, and hornworts. In the same line, ethnobryology was introduced approximately 70 years ago to investigate the traditional uses of bryophytes (Harris 2008). At the global scale, several studies have documented traditional uses of bryophytes (Hernández-Rodríguez & Delgadillo-Moya 2021, Hernández-Rodríguez & López-Santiago 2022; Motti *et al.* 2023). Ecuador is one of the countries with the highest levels of bryophyte diversity, with nearly 1,650 species recorded (Churchill *et al.* 2000; León-Yánez *et al.* 2006; Benítez & Gradstein 2011; Benítez *et al.* 2012). In contrast, the Galápagos Islands have only 113 species (Gradstein 2009; Gradstein & Ziemeck 2016). In Ecuador mosses represent the most diverse group with approximately 950 species (Churchill *et al.* 2000), followed by around 700 species of liverworts and about 20 hornwort species (Gradstein 2021). The most diverse moss families in Ecuador are Pottiaceae and Bryaceae (Churchill 2012), whereas among liverworts Lejeuneaceae, Plagiochilaceae, and Frullaniaceae (Gradstein 2021). For hornworts, the most diverse families are the Notothyladaceae and Dendrocerotaceae (Gradstein 2021). Despite this high diversity, no studies have specifically documented the traditional uses of bryophyte species in Ecuador. In contrast, ethnobotanical research on vascular plants has been widely conducted across all regions of the country (Duchelle 2007; Pila & Maqueda 2023; Noriega *et al.* 2024; Tinitana *et al.* 2025).

In Ecuador, research conducted in tropical montane forests of the San Francisco Biological Reserve in southern Ecuador has provided important contributions to the study of bryophyte taxonomy, ecology and molecular biology (Kautz & Gradstein 2001; Parolly & Kürschner 2004; Parolly *et al.* 2004; Nöske & Sipman 2004; Andersson & Gradstein 2005; Schäfer-Verwimp *et al.* 2006). More recent studies have addressed patterns of diversity (Benítez & Gradstein 2011; Gradstein & Benítez 2014a; Gradstein & Benítez 2016; Gradstein & León-Yánez 2018; Gradstein & Benítez 2018), anthropogenic disturbances (Benítez *et al.* 2019; Yangua-Solano *et al.* 2023), water quality (Vásquez *et al.* 2019), and air quality (Benítez *et al.* 2020) in natural and anthropogenic ecosystems of southern Ecuador. In addition, phytochemical studies on bryophytes have increased in recent years (Morocho *et al.* 2024; Andrade *et al.* 2025). Therefore, this study aimed (i) to identify potential bryophyte species with ethnobryological uses in Ecuador, and (ii) to analyze temporal research trends in bryology and ethnobryology in Ecuador between 1990 and 2025.

Materials and Methods

Data collection

A systematic review of bryological research conducted over the last three decades in continental Ecuador and the Galápagos Islands was performed based on an adaptation of the PRISMA method, which ensures the quality of systematic review articles (Moher *et al.* 2009), combined with a protocol applied in educational research focused on the planning, implementation, and reporting of results (Torres-Carrión *et al.* 2018).

The systematic review of scientific articles began with searches in Latindex (local scope), SciELO and Redalyc (regional scope), and Scopus and Web of Science (global scope). The following keywords were used: “Bryophytes Ecuador”, “Bryology Ecuador”, “Ethnobryology Ecuador”, “Mosses Ecuador”, “Liverworts Ecuador”, “Hornworts Ecuador” and “Bryophytes and Galapagos”. Articles were initially screened through title and abstract reading, followed by a rapid full-text assessment to evaluate methodological approaches and main results. Studies addressing ecological, taxonomic, molecular biology, and phytochemical topics were subsequently reviewed comprehensively.

Data Analysis

Descriptive statistics were applied using line and bar charts to visualize research trends over time, as well as distributions by taxonomic group, growth habit, and research topic (taxonomy, ecology, molecular, phytochemistry and ethnobryology).

Results and Discussion

Trends in bryophyte research between 1990 and 2025

A total of 107 scientific articles were recorded between 1990 and 2025. From 1990 to 2007, numbers of articles remained low, ranging from one to four studies per year (Figure 1). However, from 2008 year, the number of articles increased markedly, with the highest peaks occurring in 2020 and 2021 (Burghardt & Uribe 2020; Gradstein 2020; Valarezo *et al.* 2018, 2020; Díaz *et al.* 2021; Medina *et al.* 2021).

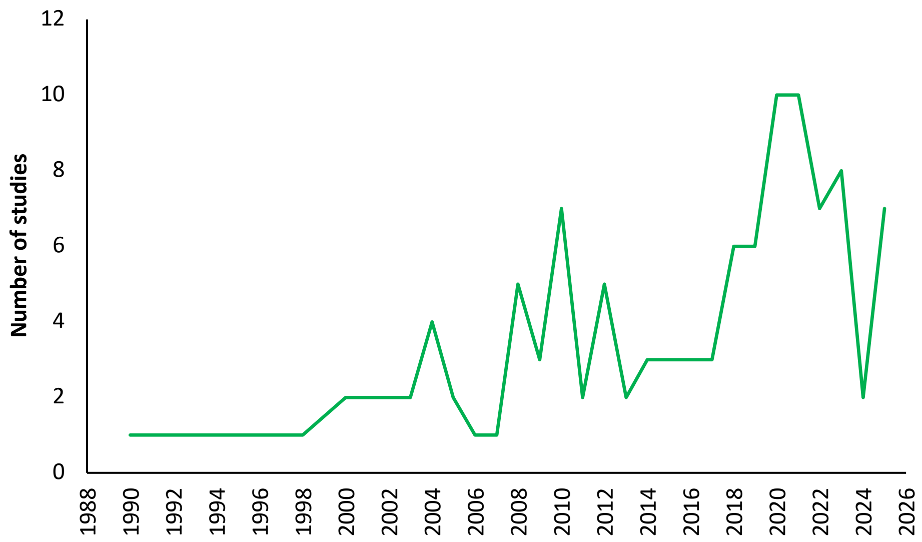

Figure 1. Number of studies published between 1990 and 2025.

Studies were predominantly focused on bryophytes (82 studies), followed by combined bryophyte-lichens groups, for example Mandl *et al.* (2010) and González *et al.* (2017), and finally by studies on biological soil crusts (Figure 2). In this context, the three biological soil crust studies conducted in Ecuador were focused in the provinces of Loja and Azuay (Castillo-Monroy & Benítez 2015; Castillo-Monroy *et al.* 2016; Ruiz *et al.* 2023). A similar pattern has been observed across South American countries (Brazil, Chile, and Argentina), where biological soil crust research remains limited (Romero *et al.* 2020; Samolov *et al.* 2020; De Lima *et al.* 2021).

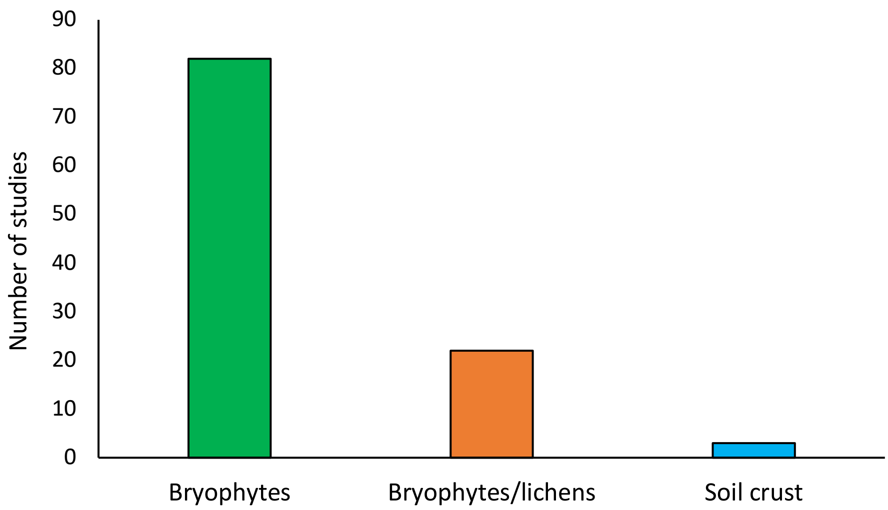

Figure 2. Number of studies focused on bryophytes, bryophyte-lichens, and biological soil crusts.

Epiphytic bryophytes (39 studies) were the most studied group (Benítez *et al.* 2023b,c), followed by terricolous (Mandl *et al.* 2009; Benítez *et al.* 2015; Salinas *et al.* 2022), aquatic, and saxicolous species (Gradstein & Burghardt 2008; Vanderpoorten *et al.* 2010), while the epiphyllous habitat was represented by two studies (Pócs & Schäfer-Verwimp 2012; Gradstein *et al.*

2018). This pattern highlights a clear research gap regarding aquatic, saxicolous, and epiphyllous bryophytes in Ecuador (Figure 3). In general, epiphytic bryophytes have been the primary focus of research in Ecuador (Andersson & Gradstein 2005; Fleischbein *et al.* 2005; Werner & Gradstein 2009; Gradstein & Sporn 2010; Karger *et al.* 2012; Berdugo *et al.* 2022; Benítez & Freire-Fierro 2025), while studies on terricolous bryophytes have increased in recent years (Sklenár *et al.* 2010; Jiménez *et al.* 2012; Maciel-Silva *et al.* 2016; Gradstein *et al.* 2019).

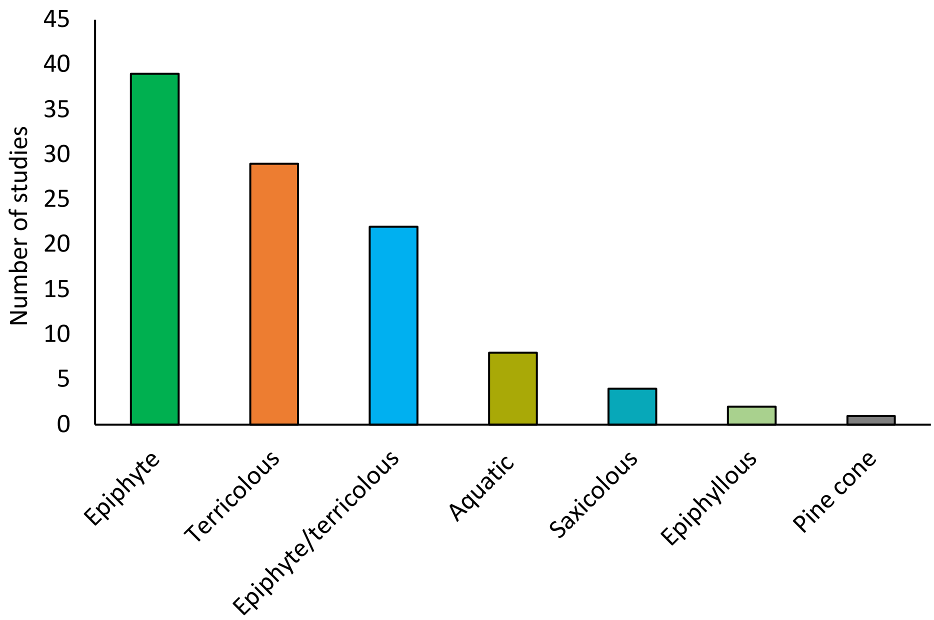

Figure 3. Bryophyte occurrence by substrate type (epiphytic, terricolous, aquatic, saxicolous, and epiphyllous).

Most studies were conducted in Loja Province (Heinrichs *et al.* 2015; Carrillo *et al.* 2022; Benítez *et al.* 2024, 2025; Ganazhapa-Plasencia *et al.* 2025a, b), followed by Pichincha (Noriega *et al.* 2008; Ellis *et al.* 2020, 2021, 2022), Zamora Chinchipe (Schäfer-Verwimp *et al.* 2013; Costa *et al.* 2018), and studies that included both southern provinces of Loja and Zamora Chinchipe (Figure 4). In contrast, Napo, Morona Santiago, Azuay, Chimborazo, Cotopaxi, Orellana, and the Galápagos Islands (Yamada & Gradstein 1991; Miquel & Bungartz 2017) were represented by only one to three studies each (Figure 4). The high number of studies conducted in Loja Province is related to the presence of the San Francisco Research Station of the German Research Foundation, located between the provinces of Loja and Zamora-Chinchipe, where several bryophyte studies have been carried out by bryological specialists, for example Robert Gradstein, Alfons Schäfer-Verwimp, Harald Kürschner, Martin Nebel and Gerald Parolly (Parolly *et al.* 2004). In addition, the bryological research group of the Universidad Técnica Particular de Loja has developed several projects and studies focused on the taxonomy and ecology of Ecuadorian bryophytes (Benítez *et al.* 20219).

Research in Ecuador has primarily focused on ecological topics, followed by taxonomical studies, molecular, and finally phytochemical research (Figure 5). However, ethnobryological topics remain entirely unexplored in Ecuador, and the traditional knowledge and potential uses of bryophytes are still largely undocumented. Medicinal uses of bryophytes in Ecuador have only been reported for the moss *Orthostichopsis tortipilis* (Müll. Hal.) Broth. (Harris 2008).

Taxonomical studies

The most studies have focused on the description of new species, resulting in a total of 29 bryophyte species new to science over the last three decades, where 22 correspond to foliose liverworts (Schafer-Verwinp 2004; Gradstein *et al.* 2011;Gradstein & Schäfer-Verwimp 2012; Gradstein & Benitez 2014a,b; Crandall-stotler & Gradstein 2017; Gradstein & Reiner-Drehwald 2007; Gradstein 2021), five to thalloid liverworts (Preußing *et al.* 2010a, b; Gradstein & León-Yánez 2018; Gradstein *et al.* 2019; Burghardt & Uribe 2020), and two to mosses (Jiménez *et al.* 2012). In Ecuador, liverworts represent the most intensively studied group (Engel & Gradstein 2003; Gradstein *et al.* 2004; Burghardt & Gradstein 2008; Gradstein & Reeb 2018), as only two new moss species have been reported between 1990 and 2025 (Churchill 1990; Jiménez *et al.* 2012). In addition, several studies have focused on localized zones (Arts & Sollman 1998; Kuc 2000; Nöske *et al.* 2003; Parolly *et al.* 2004; Churchill *et al.* 2009; Benítez & Gradstein 2011; Schäfer-Verwimp *et al.* 2013b; Burghardt 2020; Gradstein 2020;

Gradstein & Pérez 2021; Burghardt 2022a, b), as well as on reporting new national records of mosses and liverworts (Ellis *et al.* 2014, 2019a,b, 2020a,b, 2021a,b, 2022a,b, 2023; Burghardt 2019, 2021; Benítez *et al.* 2021b). Thus, taxonomic studies in Ecuador have primarily focused on the documentation of new records and localized floristic inventories.

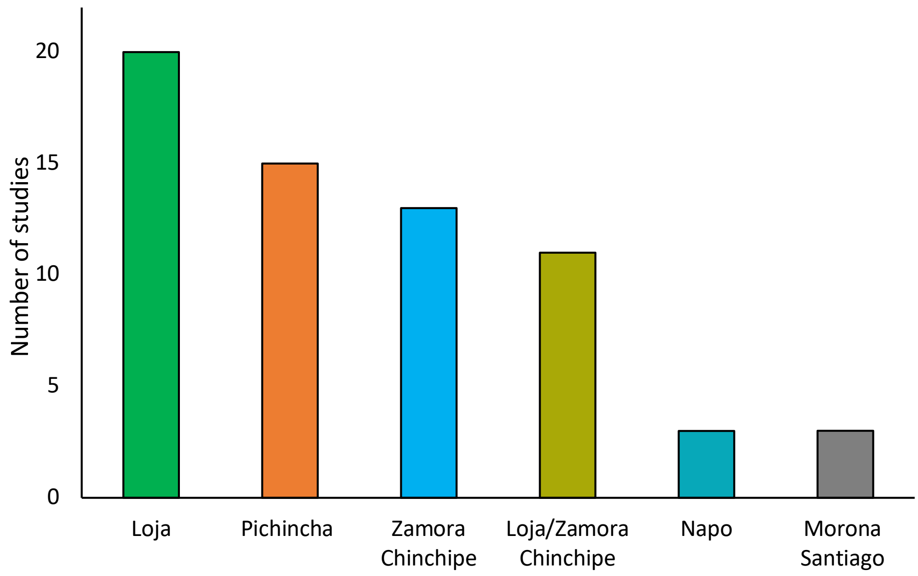

Figure 4. Number of bryophyte studies by province in Ecuador.

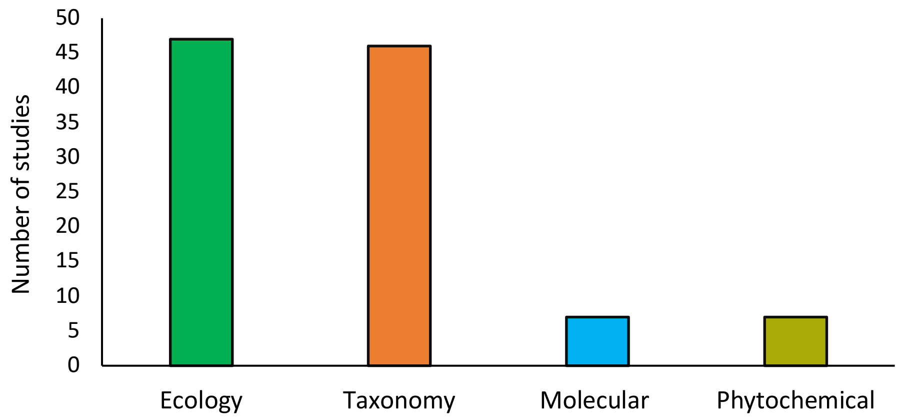

Figure 5. Distribution of bryophyte studies across research topics (taxonomy, ecology, molecular biology, and phytochemistry).

Ecological studies

Most ecological studies have examined bryophyte and bryophyte-lichen diversity as indicators of anthropogenic disturbance in montane and Amazonian forests (Freiberg & Freiberg 2000; Andersson & Gradstein 2005; Nöske *et al.* 2008; Werner & Gradstein 2009; Werner & Gradstein 2010; Medina *et al.* 2021; Gradstein & León-Yánez 2020; Fernández-Prado *et al.* 2023; Benítez *et al.* 2023b; Maul *et al.* 2025), as well as indicators of water pollution (Vásquez *et al.* 2019; Benítez *et al.* 2020) and metal-related air pollution (Díaz *et al.* 2021; Benítez *et al.* 2021). Other studies have addressed snail communities associated with bryophyte cover (Miquel & Bungartz 2017), bryophyte diversity in bird nests (Benítez *et al.* 2023a), and bryophytes growing on pinecones (Benítez 2025). However, several promising ecological topics remain unexplored in Ecuador, including species distribution modeling (Burneo & Benítez 2020), the use of aquatic bryophytes as indicators of microplastics in freshwater ecosystems (Carrieri *et al.* 2022), and the potential of bryophytes for phytoremediation and phytofiltration of water contaminants such as arsenic (Sandhi *et al.* 2018). Active biomonitoring of water quality with bryophytes is a particularly promising approach that has not yet been assessed in Ecuador (Debén *et al.* 2017), where current research has been limited to passive monitoring of water quality (Vásquez *et al.* 2019; Benítez *et al.* 2020) and active monitoring of air quality (Noriega *et al.* 2008; Benítez *et al.* 2021). In addition, studies on bryophytes as indicators of habitat fragmentation (Alvarenga *et al.* 2007; Zartman 2003; Pharo & Zartman 2007; Silva & Pôrto 2009), airborne microplastics (Roblin & Aherne 2020; Capozzi *et al.* 2023), and particulate matter (Meyer *et al.* 2010) have not yet been conducted in Ecuador.

Molecular studies

In the molecular topic, research has been conducted on a limited number of bryophyte species, contributing to additions to the bryophyte flora of Ecuador. For example, molecular analyses of *Plagiochila buchtiniana* Steph. (Schäfer-Verwimp *et al.* 2006) and relationship of *Aneura pinguis* (L.) Dumort. from Europe and Ecuador based on diversity patterns of associated *Tulasnella* fungi (Preußing *et al.* 2010a). Additionally, evolutionary relationships within the family Aneuraceae were investigated, leading to the description of two new species of the genus *Lobatiriccardia* (Preußing *et al.* 2010b). In the same line, the description of *Cololejeunea stotleriana* Gradst., Ilk.-Borg. & Vanderp. as new to science (Gradstein *et al.* 2011) and the establishment of *Reinerantha foliicola* Gradst. & R.L.Zhu as a new genus and species of epiphyllous foliose liverwort (Gradstein *et al.* 2018). However, most molecular studies in Ecuador have focused primarily on species delimitation and taxonomic description rather than on broader evolutionary topics such as bryophyte phylogeography, which has been widely explored in other countries (Vanderpoorten *et al.* 2008; Heinrichs *et al.* 2009; Yin *et al.* 2023; Lee *et al.* 2023).

Phytochemical studies

The few studies reported secondary metabolites in the liverworts *Symphyogyna brasiliensis* and *Noteroclada confluens* (Ludwiczuk *et al.* 2008). Subsequently, Costa *et al.* (2018) described secondary metabolites in the leafy liverwort *Syzygiella rubricaulis* within the Neotropical region. More recently, secondary metabolites have been characterized in several foliose liverwort species (Valarezo *et al.* 2020, 2023; Morocho *et al.* 2024; Andrade *et al.* 2025) and in mosses (Valarezo *et al.* 2018) from southern Ecuador. Despite these advances, phytochemical research has largely remained descriptive, focusing on compound identification rather than evaluating biological activity (Andrade *et al.* 2025) or potential pharmaceutical applications of bryophytes, as has been documented in other countries (Singh *et al.* 2011; Makajanma *et al.* 2020; Rodrigues *et al.* 2020; Sen *et al.* 2023).

Ethnobryological studies

The uses of 28 species of bryophyte distributed in Ecuador were reported (Figure 6 and Table 1). Mosses represented the largest number of species, followed by liverworts and a one species of hornwort. However, these species account for less than 2% of the 1,650 bryophyte species recorded in Ecuador. Medicinal use (90%) was the most common across most species, although decorative uses (10%) were also identified in a small number of species. Nevertheless, studies from other countries have documented the use of species belonging to widely distributed Ecuadorian bryophyte genera, such as *Fissidens, Phyllonotis, Plagiochila, Plagiomnium, Riccardia, Pogonatum* and *Sematophyllum* (Motti *et al.* 2023), as well as *Neckera, Bazzania* and *Herbertus* (Harris 2008). These findings highlight the considerable ethnobryological potential of many bryophyte species in Ecuador that remains undocumented.

Conclusion

A total of 107 scientific articles were recorded between 1990 and 2025. Over time, publication output did not follow a steady growth trend; however, a marked increase was observed from 2018, with an average of approximately six studies per year. Most research focused exclusively on bryophytes, followed by combined bryophyte/lichens studies, while only three studies were focused in biological soil crusts. Epiphytic bryophytes were the most frequently investigated, followed by terricolous species, whereas saxicolous and epiphyllous bryophytes were the least studied. Loja, Pichincha, and Zamora Chinchipe provinces recorded the highest number of articles, ranging from 13 to 20 studies, while provinces such as Azuay, Chimborazo, Cotopaxi, Orellana, and the Galápagos Islands were represented by only one to three studies. Ecological research showed largest proportion of studies, followed by taxonomic investigations, whereas only seven and six studies focused on molecular and phytochemical topics, respectively. No ethnobryological studies were identified; therefore, this review reports, for the first time, the traditional uses of 28 bryophyte species in Ecuador. Overall, most studies have concentrated on localized inventories, molecular-based species descriptions, environmental bioindication, and phytochemical characterization, largely restricted to specific ecosystems in Loja, Pichincha, and Zamora Chinchipe. This synthesis highlights the urgent need to expand ecological, molecular, phytochemical, and ethnobryological research across underexplored provinces of Ecuador.

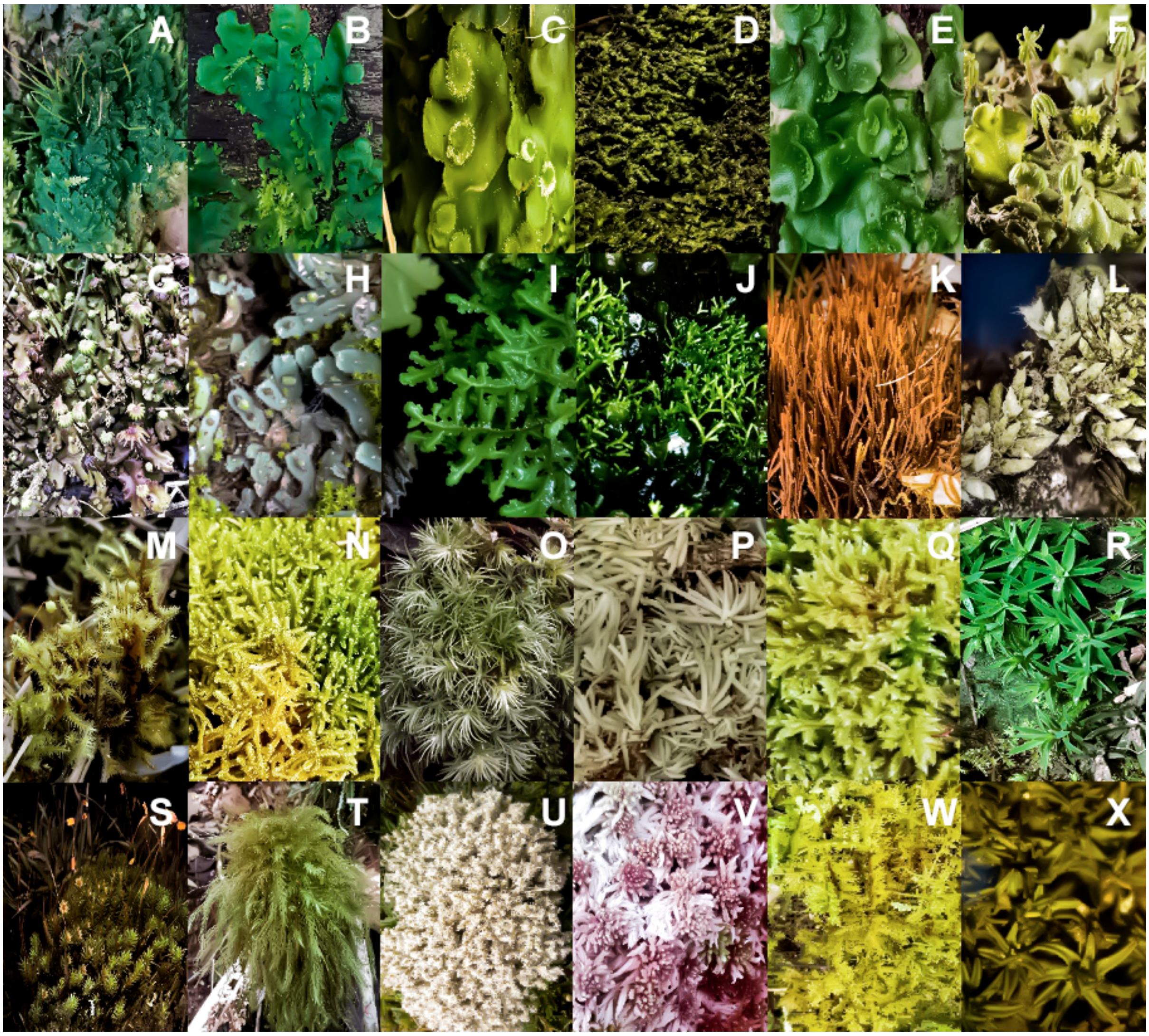

Figure 6. A. *Anthoceros punctatus* B. *Aneura pinguis* C. *Dumortiera hirsuta* D. *Frullania ericoides* E. *Lunularia cruciata* F. *Marchantia chenopoda* G. *Marchantia polymorpha* H. *Plagiochasma rupestre* I. *Radula voluta* J. *Riccia fluitans* K. *Syzygiella rubricaulis* L. *Bryum argenteum* M. *Breutelia tomentosa* N. *Hypnum cupressiforme* O. *Leucobryum martianum* P. *Octoblepharum albidum* Q. *Pleurozium schreberi* R. *Polytrichastrum tenellum* S. *Polytrichum juniperinum* T. *Pyrrhobryum spiniforme* U. *Racomitrium lanuginosum* V. *Sphagnum magellanicum* W. *Thuidium delicatulum* X. *Weissia controversa*

Table 1. Ethnobiological knowledge of bryophytes in Ecuador

	Species	Bryophyte group	Uses	References	Phytochemical studies in Ecuador
Anthocerophyta					
Anthocerotaceae	*Anthoceros punctatus* L.	Anthoceros	Medicinal properties (Treat fever and for detoxification)	Halder & Mitra 2020	Not evaluated
Marchantyophyta					
Aneuraceae	*Aneura pinguis* (L.) Dumort.	Thallose liverwort	Antibacterial (contains iodine)	Drobnik & Stebel, 2021	Not evaluated
Lejeuneaceae	*Archilejeunea ludoviciana* subsp. porelloides (Spruce) Gradst.	Foliose liverwort	Traditionally used for the relief of chest pain	Motti *et al.* 2023	Not evaluated
Dumortieraceae	*Dumortiera hirsuta* (Sw.) Nees	Thallose liverwort	Antibacterial	Mukherjee *et al.* 2012	Not evaluated
Frullaniaceae	*Frullania ericoides* (Nees ex Mart.) Mont.	Foliose liverwort	To eliminate head lice and promote hair nourishment	Motti *et al.* 2023	Not evaluated
Lunulariaceae	*Lunularia cruciata* (L.) Dumort.	Thallose liverwort	To treat disorders of the urinary tract and kidneys and remedy for fainting in married women.	Motti *et al.* 2023	Not evaluated
Marchantiaceae	*Marchantia chenopoda* L.	Thallose liverwort	Antimicrobial, antifungal and antiviral	Drobnik & Stebel 2021	Not evaluated
Marchantiaceae	*Marchantia polymorpha* L.	Thallose liverwort	Diuretic and in the treatment of liver disorders, pulmonary tuberculosis, and cardiovascular diseases. It is also used for skin inflammations, burns, scalds, and open wounds.	Asakawa, 2007, Harris 2008; Motti *et al.* 2023	Not evaluated
Aytoniaceae	*Plagiochasma rupestre* (J.R.Forst. & G.Forst.) Steph.	Thallose liverwort	To treat disorders of the urinary tract and kidneys. Also used as a remedy for fainting in married women.	Motti *et al.* 2023	Not evaluated
Radulaceae	*Radula voluta* Taylor	Foliose liverwort	Antiparasitic	Andrade *et al.* 2025	Andrade *et al.* 2025
Ricciaceae	*Riccia fluitans* L.	Thallose liverwort	Useful in healing wounds and infections	Motti *et al.* 2023	Not evaluated
Jamesoniellaceae	*Syzygiella rubricaulis* (Nees) Stephani	Foliose liverwort	Antimicrobial, Antioxidant, and Anticholinesterase	Morocho *et al.* 2024	Morocho *et al.* 2024
Bryophyta					

Bryaceae	*Bryum argenteum* Hedw.	Acrocarpous moss	Nasal inflammation, antipyretic activity, antibacterial and antifungal properties; treatment of dysentery	Motti *et al.* 2023	Not evaluated
Bartramiaceae	*Breutelia tomentosa* (Sw. ex Brid.) A.Jaeger	Acrocarpous moss	Decoration	Harris 2008	Valarezo *et al.* 2018
Hypnaceae	*Hypnum cupressiforme* Hedw.	Pleurocarpous moss	Decoration in moss man costumbre	Sabovljević *et al.* 2016	Not evaluated
Hypnaceae	*Isopterygium tenerum* (Sw.) Mitt.	Pleurocarpous moss	Rheumatism	Motti *et al.* 2023	Not evaluated
Leucobryaceae	*Leucobryum martianum* (Hornsch.) Hampe ex Müll. Hal.	Acrocarpous moss	Antibacterial	Asakawa, 2007	Not evaluated
Dicranaceae	*Octoblepharum albidum* Hedw.	Acrocarpous moss	used to treat headaches, fever, and body aches; also used as a sedative	Chandra *et al.* 2017; Motti *et al.* 2023	Not evaluated
Pterobryaceae	*Orthostichopsis tortipilis* (Müll. Hal.) Broth.	Pleurocarpous moss	Used to treat cuts, stomach ache, and snake bites	Harris 2008; Motti *et al.* 2023	Not evaluated
Mniaceae	*Plagiomnium cuspidatum* (Hedw.) T. Kop.	Pleurocarpous moss	Hemostatic	Motti *et al.* 2023	Not evaluated
Hylocomiaceae	*Pleurozium schreberi* (Willd. ex Brid.) Mitt.	Pleurocarpous moss	Antibacterial and antioxidant activities. Scrub disshes and chinking material in log cabins	Wolski *et al.* 2023	Not evaluated
Polytrichaceae	*Polytrichastrum tenellum* (Müll. Hal.) G.L. Sm.	Acrocarpous moss	Sedative effects, cough relief, and hemostatic activity	Motti *et al.* 2023	Not evaluated
Polytrichaceae	*Polytrichum juniperinum* Hedw.	Acrocarpous moss	Prostate disorders, urinary difficulties, and the treatment of sores, boils, and swelling	Motti *et al.* 2023	Not evaluated
Rhizogoniaceae	*Pyrrhobryum spiniforme* (Hedw.) Mitt.	Pleurocarpous moss	Fever and bowel complaints	Motti *et al.* 2023	Not evaluated
Grimmiaceae	*Racomitrium lanuginosum* (Hedw.) Brid.	Acrocarpous moss	Used as lamp wick	Harris 2008	Not evaluated
Sphagnaceae	*Sphagnum magellanicum* Brid.	Acrocarpous moss	Antimicrobial purposes, as surgical dressings, and in infant diapers	Motti *et al.* 2023	Not evaluated
Thuidiaceae	*Thuidium delicatulum* (Hedw.) Schimp.	Pleurocarpous moss	Decoration for native scenes and chinking material	Harris 2008	Not evaluated
Pottiaceae	*Weisia controversa* Hedwig	Acrocarpous moss	To reduce heat and alleviate toxicity; used for nasal inflammation and sinus conditions	Harris 2008; Motti *et al.* 2023	Not evaluated

Declarations

List of abbreviations: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
Ethics approval and consent to participate: No special permit was required for this work.
Consent for publication: This article has not been published previously. All authors agreed for submission.
Availability of data and materials: All the information gathered for this research was examined, interpreted, and incorporated into this research
Competing interests: Not applicable
Funding: This research was funded by the Universidad Técnica Particular de Loja, grant POA-VIN-056.
Author contributions: Conceptualization, Á. B. and M.V.; methodology, Á. B., E.Y-S. and M.V.; formal analysis, Á. B., E.Y-S. and M.V.; investigation, Á. B., E.Y-S. and M.V.; writing—original draft preparation, Á. B., E.Y-S. and M.V.; writing—review and editing, Á. B., E.Y-S. and M.V.
Competing interests: The authors declare no competing interests.

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