

Bryoflora of Gallery Forest in Quirinópolis, Goiás State, Brazil¹

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Received: 29.08.2014; accepted: 23.03.2015

ABSTRACT - (Bryoflora of Gallery Forest in Quirinópolis, Goiás State, Brazil). This study provides a survey of the bryophytes in gallery forest in the municipality of Quirinópolis, Goiás State, Brazil. Samples were collected monthly from April 2012 to July 2013. The substrate colonization and frequency of species were analyzed. The material was collected according to the usual procedures and is deposited at HerBJAR of UEG. We found 38 species of bryophytes (25 mosses and 13 liverworts). The richest families were Hypnaceae for mosses and Lejeuneaceae for liverworts, with five and seven species recorded, respectively. *Isopterygium tenerum* (Sw.) Mitt. was the most frequent species, and has a wide distribution in Brazil. *Dicranodontium pulchroalare* subsp. *brasiliense* (Herzog) J.-P.Frahm is a new record for the Cerrado, and *Philonotis sphaerocarpa* (Hedw.) Brid., *Lejeunea caulicalyx* (Steph.) E. Reiner, and *L. quinque-umbonata* Spruce are new records for Goiás State.

Keywords: Brazilian savanna, bryophytes, liverworts, mosses, wetlands

RESUMO - (Brioflora de Mata de Galeria Inundável em Quirinópolis, Estado de Goiás, Brasil). O presente estudo objetivou realizar um levantamento da brioflora em mata de galeria no município de Quirinópolis, Goiás. As coletas foram realizadas mensalmente de abril de 2012 a julho de 2013. Foram analisadas a colonização do substrato e a frequência das espécies. O material coletado foi herborizado conforme os procedimentos usuais e está depositado no HerBJAR da UEG. As identificações foram feitas por especialistas. Foram encontradas 38 espécies de briófitas (25 musgos e 13 hepáticas). As famílias mais ricas foram Hypnaceae para musgos e Lejeuneaceae para hepáticas, com cinco e sete espécies registradas, respectivamente. *Isopterygium tenerum* (Sw.) Mitt. foi a espécie mais frequente, o qual apresenta ampla distribuição no Brasil. *Dicranodontium pulchroalare* subsp. *brasiliense* (Herzog) J.-P.Frahm é um novo registro para o bioma Cerrado, e *Philonotis sphaerocarpa* (Hedw.) Brid., *Lejeunea caulicalyx* (Steph.) E. Reiner e *L. quinque-umbonata* Spruce novos registros para o Estado de Goiás. Palavras-chave: áreas úmidas, briófitas, Cerrado, hepática, musgo

Introduction

The Cerrado is the second largest Brazilian biome in extension (Silva *et al.* 2008), formed by different phytophysionomies (Visnadi 2004). The gallery forests constitute the humid areas in the Cerrado, occupying the banks of streams and small rivers, forming closed corridors above them (Ribeiro & Walter 2008). These environments are proper to the

occurrence of bryophytes, since these plants exhibit dependence on water for reproduction (Weberling & Schwantes 1986).

One of the first surveys on the bryoflora in the Cerrado has been performed in Distrito Federal (Filgueiras & Pereira 1993), who reported 126 species of bryophytes. Since then, the number of bryologic inventories has increased in the last years (Glime 2006, Alvarenga *et al.* 2007). Today, 479 species are listed to

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Cerrado, and 309 of these species to Goiás State (Yano & Costa 2000, Gradstein *et al.* 2005, Yano & Peralta 2007, Yano & Peralta 2008, Costa 2013).

The bryologic surveys in the Cerrado have focus on floristic surveys (Vital 1983, Egunyomi & Vital 1984, Vilas Bôas-Bastos & Bastos 1998, Visnadi & Vital 2001, Castro *et al.* 2002, Visnadi 2004). The studies involving the abundance and richness of bryophytes are few, and there are only two studies on gallery forests (Peralta & Yano 2005, Genevro *et al.* 2006). For the of Goiás State, the survey in the gallery forest of Vale da Lua, Chapada dos Veadeiros with 33 species of mosses (Faria *et al.* 2012, Pinheiro *et al.* 2012), which registered 36 species of liverworts, being six new records for the Center-West and eight new records for Goiás State, and registered 52 new species of moss, being 15 new records for Goiás State, 7 for the Center-West Region, in clumps at Parque Nacional da Chapada dos Veadeiros (Pinheiro 2012).

Thus, in order to contribute to the knowledge on the distribution and richness of the bryoflora, this study aimed to evaluate the diversity and richness of bryophytes in the gallery forest of Quirinópolis, Goiás State.

Material and methods

The study area is a gallery forest in the city Quirinópolis, located around 50 km from the county seat (18°33'2.76"S - 50°46'7.99"W) of Quirinópolis, Goiás State. The municipality is part of the Cerrado biome, in the Microregion 18 and Mesoregion South Goiano (IBGE 2010).

The samples were made between April 2012 and July 2013, following the usual methodology proposed by Frahm (2003). The specimens were collected through the polygonation method (Filgueiras *et al.* 1994), in a way to cover the different environmental gradients present in the phytophysionomy studied.

According to the substrate where the samples were collected, they were classified as corticolous, on the bark of living trees; epixylous, on dead or decaying wood; epiphyllous, on living leaves; rupicolous, on rocks; and terricolous, on the soil or litter (Robbins 1952).

The material collected was herborized according to the usual procedures and included in the collection of José Ângelo Rizzo Herbarium (HERBJAR), of the Universidade Estadual de Goiás (UEG), Unidade de Quirinópolis.

The absolute frequency of the species was determined based on the number of occurrences,

where five classes were defined: 1-5: rare, 6-10: infrequent; 11-20: assiduous; 21-30: frequent; and > 31: very frequent (Silva & Pôrto 2007). The assiduous, frequent and very frequent species were classified into photophilic species (those occurring in sunny locations in open areas of gallery forest), shade species (those that occur in the shaded areas of the gallery forest), and generalists (adapted from Gradstein 1992).

The identification of the samples was based on the work of Yano (1975), Vital (1980), Reese (1993), Gradstein (1994), Sharp *et al.* (1994), Buck and Goffinet (2000), Crandall-Stotler and Stotler (2000), Buck (2003), Gradstein and Costa (2003), Stotler and Crandall-Stotler (2005), Alvarenga *et al.* (2007), Pursell (2007); and compared to the samples identified by experts previously.

The classification system adopted was Buck and Goffinet (2000) to Bryophyta and Crandall-Stotler & Stotler (2000) to Marchantiophyta.

Results and Discussion

Were studied 139 samples and 38 species of bryophytes were found. Mosses are represented by 14 families, 21 genera and 25 species, and liverworts by six families, 10 genera and 13 species. One morphospecie of Lejeuneaceae was identified in genus for not having the necessary structures for the identification of the specie (table 1).

In the study area, some species considered rare were sampled because they were poorly sampled in the country, being these the *Dicranodontium pulchroalare* subsp. *brasiliense*, *Orthostichidium quadrangulare* mosses, and the *Riccardia chamedryfolia*, *Taxilejeunea isocalycina*, *Zoopsidella macella* e *Porella swartziana* liverworts.

Dicranodontium pulchroalare subsp. *brasiliense*, an endemic species to Brazil, is a new occurrence for the Cerrado biome. This moss had only been sampled in the Mata Atlântica, in the States of Ceará, Minas Gerais, and Rio de Janeiro (Costa & Peralta 2014).

Philonotis sphaerocarpa, *Lejeunea caulicalyx* and *L. quinque-umbonata* are new records for Goiás State. *Taxilejeunea isocalycina* constituted a new record for the Goiás State in a survey in two paths of Quirinópolis, Goiás State, being collected on soil, in light and humid locations (Bernardes *et al.* 2012). All other species found are widely distributed in Brazil and in other neotropical areas, occurring in at least four Brazilian States (Costa & Peralta 2014).

Table 1. Species found in a swamp gallery forest of Quirinópolis, Goiás State, Brazil, listed in alphabetical order by family. *: New record for the Goiás State. **: New record for the Center-West region. Substrate: C: corticolous; EX: epixylous; T: terricolous; R: rupicolous. Freq.: Number of samples.

| Category/Family | Species | Substrate type | | | | Freq. | Voucher |
|---------------------------------------|--|----------------|----|----|---|-------|--------------|
| | | C | EX | T | R | | |
| Bryophyta | | | | | | | |
| Bartramiaceae | <i>Philonotis sphaerocarpa</i> (Hedw.) Brid.* | | | X | | 2 | Aquino 29 |
| Dicranaceae | <i>Dicranodontium pulchroalare</i> subsp. <i>brasiliense</i> (Herzog) J.-P. Frahm.** | | | X | | 1 | Resende 1715 |
| | <i>Ochrobryum gardneri</i> (Müll. Hal.) Mitt. | X | | | | 3 | Aquino 65 |
| Entodontaceae | <i>Erythrodontium longisetum</i> (Hook.) Paris | X | | | | 3 | Resende 1694 |
| Fissidentaceae | <i>Fissidens hornschurchii</i> Mont. | X | | | | 1 | Aquino 6 |
| Hypnaceae | <i>Chryso-hypnum diminutivum</i> (Hampe) W.R. Buck | X | X | X | X | 16 | Aquino 52 |
| | <i>Chryso-hypnum elegantulum</i> (Hook.) Hampe | X | | | | 1 | Aquino 38 |
| | <i>Isopterygium tenerifolium</i> Mitt. | X | X | X | | 6 | Aquino 22 |
| | <i>Isopterygium tenerum</i> (Sw.) Mitt. | X | X | X | | 30 | Aquino 88 |
| | <i>Vesicularia vesicularis</i> (Schwäegr.) Broth. | | | X | | 1 | Aquino 72 |
| Meteoriaceae | <i>Floribundaria flaccida</i> (Mitt.) Broth. | X | | | | 1 | Resende 1704 |
| | <i>Meteorium nigrescens</i> (Hedw.) Dozy & Molk. | X | X | | | 13 | Resende 1700 |
| Neckeraceae | <i>Neckeropsis disticha</i> (Hedw.) Kindb. | X | | | | 1 | Resende 1646 |
| | <i>Neckeropsis undulata</i> (Hedw.) Reichardt | X | X | | | 16 | Resende 1697 |
| Pilotrichaceae | <i>Callicostella pallida</i> (Hornsch.) Ângstr. | X | | | | 1 | Aquino 4 |
| | <i>Cyclodictyon albicans</i> (Hedw.) O. Kuntze | | X | | | 1 | Aquino 85 |
| Pottiaceae | <i>Pseudosymblepharis schimperiana</i> (Paris) H.A.Crum | X | | | | 2 | Resende 1727 |
| Pterobryaceae | <i>Henicodium geniculatum</i> (Mitt.) W.R. Buck | X | | | | 1 | Aquino 75 |
| | <i>Jaegerina scariosa</i> (Lorentz) Arzeni | X | | | | 6 | Aquino 71 |
| | <i>Orthostichidium quadrangulare</i> (Schwägr.) B.H. Allen | X | | | | 1 | Resende 1649 |
| Racopilaceae | <i>Racopilum tomentosum</i> (Hedw.) Brid. | X | | | | 2 | Resende 1657 |
| Sematophyllaceae | <i>Sematophyllum subpinnatum</i> (Brid.) E. Britton | X | | | | 1 | Aquino 82 |
| | <i>Sematophyllum subsimplex</i> (Hedw.) Mitt. | | X | | | 1 | Aquino 96 |
| Stereophyllaceae | <i>Entodontopsis leucostega</i> (Brid.) W.R. Buck & Ireland | X | | | | 2 | Aquino 64 |
| Thuidiaceae | <i>Pelekium schistocalyx</i> (Müll. Hal.) Touw | X | | X | | 2 | Aquino 79 |
| Marchantiophyta | | | | | | | |
| Aneuraceae | <i>Riccardia chamedryfolia</i> (With.) Grolle | | | X | | 1 | Resende 1714 |
| Frullaniaceae | <i>Frullania ericoides</i> (Nees ex Mart.) Mont. | X | | | | 2 | Aquino 95 |
| Lejeuneaceae | <i>Cheilolejeunea rigidula</i> (Mont.) R.M. Schust | X | | | | 1 | Aquino 24 |
| | <i>Lejeunea caulicalyx</i> (Steph.) E. Reiner & Goda* | | X | | | 1 | Aquino 91 |
| | <i>Lejeunea laetevirens</i> Nees & Mont. | X | X | | | 2 | Aquino 92 |
| | <i>Lejeunea quinque-umbonata</i> Spruce | X | | | | 3 | Aquino 5 |
| | <i>Lejeunea</i> sp. | X | | | | 1 | Resende 1732 |
| | <i>Mastigolejeunea auriculata</i> (Wilson & Hook) Schiffn. | X | X | | | 6 | Aquino 26 |
| | <i>Taxilejeunea isocalycina</i> (Nees) Steph. | X | | | | 1 | Resende 1731 |
| Lepidoziaceae | <i>Telaranea nematodes</i> (Austin) M. Howe | | | X | | 1 | Resende 1713 |
| | <i>Zoopsidella macella</i> (Spruce) R.M. Schust. | X | | | | 1 | Aquino 2 |
| Pallaviciniaceae | <i>Symphyogyna brasiliensis</i> Nees | | | X | | 1 | Resende 1716 |
| Porellaceae | <i>Porella swartziana</i> (F.Web.) Trevis. | X | | | | 3 | Resende 1703 |
| Total species found in each substrate | | 31 | 10 | 10 | 1 | | |

According to the List of Species of Brazilian Flora, regarding distribution in Brazilian phytogeographic areas, 83% of the species from the gallery forest studied occur in three or more phytogeographic areas. *Dicranodontium pulchroalare* subsp. *brasiliense* and *Orthostichidium quadrangulare* were registered as occurring only in the Mata Atlântica, and *Taxilejeunea isocalycina* as occurring in the Mata Atlântica and the Amazônia. Therefore, from the total of 35 species found (not included the six species of *Lejeunea* identified to the genus level), 34 species occur in the Mata Atlântica biome and the Cerrado (97%); 28 species occur in Amazônia (80%); 23 species occur in the Pantanal (66%); twelve species occur in the Caatinga (34%); and six species have occurred in the Pampas (17%).

Among the mosses, the family that had the highest species richness was Hypnaceae, with five species, followed by Pterobryaceae with three species, Dicranaceae, Meteoriaceae, Neckeraceae, Pilotrichaceae, and Sematophyllaceae, with two species each. All other families had only one species. Except for Dicranaceae, those were the most representative families in study in swamp forest, in the municipality of Zacarias, northwest of São Paulo State (Peralta & Yano 2005). Sematophyllaceae and Hypnaceae were also the most representative in the gallery forest at Parque Municipal Mário Viana, in Nova Xavantina, Mato Grosso State (Genevro *et al.* 2006).

In the liverworts, the family of most richness was Lejeuneaceae, with 11 species and Lepidoziaceae with two species. Lejeuneaceae is among the families with greater diversity occurring in Brazil (Costa & Luiz-Ponzo 2010), being the most representative in the study of swamp forest in the municipality of Zacarias, northwest of São Paulo State (Peralta & Yano 2005), and in the gallery forest at Parque Municipal Mário Viana, Nova Xavantina, Mato Grosso State (Genevro *et al.* 2006).

The floristic similarity between the gallery forest of the present study and the areas studied by Peralta and Yano (2005) and Genevro *et al.* (2006), measured by the index of qualitative similarity Sørensen (Mueller-Dombois & Ellenberg 1974), was of 24% and 26%, respectively. According to Kent and Coker (1992), values higher than or equal to 50% indicate high similarity. Thus, according to this concept, the similarity between the analyzed areas can be considered as low. They were common to the three wetlands among *Erythrodontium longisetum*, *Chrysohypnum diminutivum*, *Isopterygium tenerifolium*,

I. tenerum, *Callicostella pallida*, *Henicodinium geniculatum*, *Jaegerina scariosa* and *Entodontopsis leucostega* mosses; and among *Frullania ericoides*, *Cheilolejeunea rigidula* and *Mastigolejeunea auriculata* liverworts.

In studies conducted in the gallery forest of the Reserva Ecológica of IBGE, RECOR, Distrito Federal, *Ochrobryum gardneri*, *Chrysohypnum diminutivum*, *C. elegantulum*, *Isopterygium tenerum*, *Racopilum tomentosum*, *Meteorium nigrescens*, *Jaegerina scariosa*, *Sematophyllum subpinnatum*, and *S. subsimplex* were common among 41 species of mosses sampled by Câmara (2008a) and Câmara (2008b); *Riccardia chamedryfolia*, *Frullania ericoides*, *Telaranea nematodes*, and *Symphyogyna brasiliensis* were common among the 18 species of liverworts recorded by Câmara and Costa (2006). The floristic similarity between these areas and the present study was also low (21%).

The floristic similarity between areas of clumps of forest at the Parque Nacional da Chapada dos Veadeiros, Goiás State and the present study was also low (16%). Among these areas, the *Ochrobryum gardneri*, *Chrysohypnum diminutivum*, *Chrysohypnum elegantulum*, *Isopterygium tenerifolium*, *I. tenerum*, *Neckeropsis undulata*, *Jaegerina scariosa*, *Racopilum tomentosum*, and *Sematophyllum subsimplex* mosses (Pinheiro 2012); and the *Riccardia chamedryfolia*, *Frullania ericoides*, and *Telaranea nematodes* liverworts (Pinheiro *et al.* 2012) were common.

Bryophytes were found on four substrate types: moist-soil (terricolous), living bark (corticolous), decaying wood (epixyloous), and rock (rupicolous). Most species was exclusive to only one type of substrate, being the corticolous most often colonized (table 1). From the species that occurred on only one type of substrate, 23 were found on living barks, six on soil, and only three (*Cyclodictyon albicans*, *Sematophyllum subsimplex* and *Lejeunea caulicalyx*) on decaying wood. The corticolous substrate was also the most prevalent habit in swamp woods, in the municipality of Zacarias, northwest of São Paulo State (Peralta & Yano 2005) and in the gallery forest at Parque Municipal Mário Viana, in Nova Xavantina, Mato Grosso State (Genevro *et al.* 2006).

Only eight species occurred on two or more substrates. *Chrysohypnum diminutivum* was found on all substrates and the only one on rupicolous substrate. According to Yano and Peralta (2007) this species can be found on sandy substrate, as well as on walls of caves, usually occurring on rocks of humid locations.

According to the frequency, most species was considered rare due to its low number of occurrences (1 to 3). Only three species, *Isopterygium tenerifolium*, *Jaegerina scariosa*, and *Mastigolejeunea auriculata*, were considered infrequent, with six occurrences each. *Meteorium nigrescens*, *Chryso-Hypnum diminutivum*, and *Neckeropsis undulata* were considered assiduous, with 13, 16, and 16 occurrences, respectively.

Isopterygium tenerum moss was the most abundant among the analyzed samples, with 30 occurrences, being considered frequent in the region. This moss occurs throughout the Americas and has wide distribution in Brazil (Yano 2011). It was sampled on living bark, decaying wood and on the soil, along the entire length of the gallery forest studied. It is a species that commonly grows on dry locations and can also be found in waterlogged locations (Hirai *et al.* 1998), as the physiognomy studied.

Among the liverworts, the most abundant was *Mastigolejeunea auriculata*, with six occurrences. This species was sampled on living bark and on decaying wood, and had been found on soil and rock. It may be associated with *Jaegerina scariosa* and *Henicodium geniculatum* (Yano & Peralta 2008).

Among the assiduous species, *Meteorium nigrescens* is photophilic, occurring on living bark, decaying wood, and sometimes on rocks and river banks (Gradstein 1992, Yano & Peralta 2007). *Neckeropsis undulata* occurs on living bark and decaying wood, in humid forest environments, as well as being sampled on rock and moist-soil (Yano & Peralta 2007), being considered a generalist species (Gradstein 1992). *Chryso-hypnum diminutivum* was found on all sampled substrates, and is considered a generalist species. *Isopterygium tenerum*, also generalist, was found on living bark, decaying wood, and soil.

Among the species sampled in the gallery forest, only *Zoopsidella macella* does not occur in the Mata Atlântica. The low floristic similarity with other wetlands studied in the Center-West Region indicates that the bryophytes of the gallery forest of the present study differ from species surveyed in these environments. The results presented here aim to legitimize the need to intensify the inventories of the flora of bryophytes, including in gallery forests, which are largely responsible for the richness of the microbiota in the Cerrado.

Accordingly, further studies should be conducted to determine the bryoflora in the Goiás State, since three species of bryophytes are reported in this study as new records for the State and for the Cerrado biome.

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