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Original Paper
Montane seasonal wetlands: an inventory of its associated flora in Parque Estadual do Ibitipoca, southeast Brazil

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Abstract
The aim of the present study was to perform the floristic survey of the wetlands of the Parque Estadual do Ibitipoca (PEIB), comparing them regarding richness, floristic composition and life forms, based on monthly expeditions to collect vascular plants. Eighty-one (81) species were found in the moist grassland, most of them being endemic to Brazil and included in 55 genera and 21 families. The most representative families were Asteraceae (22 spp.), Melastomataceae (nine spp.), Xyridaceae (seven spp.), Poaceae and Orchidaceae (six spp. each), totalizing 62% of the sampled species. Twenty-seven (27) species were found in the seasonal pond, distributed in 23 genera and 11 families. Families with the highest specific richness were Poaceae (eight spp.), Cyperaceae and Asteraceae (five spp. each), totalizing 67% of the sampled species. There was a predominance of hemicryptophyte life form (nearly 43% of the moist grasslands and 63% of the seasonal pond) in both areas. The floristic analysis results showed great importance to conservation with 22% of species under some threatened category, 12 species endemics to Minas Gerais state and one new species of Cyperaceae. Furthermore, only five species occur in both wetland types (5.1% of the species richness).
Key words: Atlantic Forest, *campos rupestres*, macrophytes, Serra da Mantiqueira.

Resumo
O objetivo do presente trabalho foi realizar o levantamento florístico das áreas úmidas do Parque Estadual do Ibitipoca (PEIB), comparando-as em relação à riqueza, composição florística e formas de vida. Para isso, foram realizadas expedições mensais, ao longo de um ano, para a coleta de plantas vasculares. Nos campos úmidos foram encontradas 81 espécies, 55 gêneros e 21 famílias, sendo as mais representativas Asteraceae (22 spp.), Melastomataceae (nove spp.), Xyridaceae (sete spp.), Poaceae e Orchidaceae (seis spp. cada), totalizando 62% das espécies amostradas. Na lagoa temporária foram encontradas 27 espécies, distribuídas em 23 gêneros e 11 famílias. As famílias com maior riqueza específica foram Poaceae (oito spp.), Cyperaceae e Asteraceae (cinco spp. cada), totalizando 67% das espécies amostradas. Em ambas as áreas, houve predomínio da forma de vida hemicriptófita (aproximadamente 43% nos campos úmidos e 63% na lagoa sazonal). A composição florística mostrou grande importância conservacionista, com presença de doze espécies endêmicas de Minas Gerais, cerca de 22% da riqueza específica presente em alguma categoria de ameaça e a ocorrência de uma espécie nova de Cyperaceae. Além disso, apenas cinco espécies ocorreram em ambas áreas úmidas (5,1% da riqueza específica).
Palavras-chave: Floresta Atlântica, campos rupestres, macrófitas, Serra da Mantiqueira.

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Introduction

Mountain regions are hotspots of biological richness due to their environmental heterogeneity and isolation degree, providing support to understand ecological and evolutionary processes that affect ecosystem biodiversity (Körner 2004, 2007). The Serra da Mantiqueira is one of the major mountain ranges in Brazil and includes high subtropical landscapes that are distributed along the borders of four states: Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo, within the Atlantic Forest domain (Stehmann *et al*. 2009).

At over 1,200 m in this region there is a single-character environment called an altitudinal rock complex, which occurs on quartzite (*campos rupestres*) or igneous rock outcrops (*campos de altitude*) (Benites *et al*. 2003), comprising several vegetation types that differ floristically from the dominant flora and act as a refuge (IBGE 2012), with 1/3 of its richness being endemic (Giulietti *et al*. 1987) and contains some of the world's richest flora (Fernandes *et al.* 2014).

In quartzite rock outcrops (*campos rupestres*), soil depth, acidity, organic matter content and water availability lead to a mosaic landscape formation composed by predominantly herbaceous vegetation with scattered tortuous and sclerophyllous shrubs (fields on rocky or sandy outcrops) and permanent or temporary wetlands (peat bogs, moist grasslands, hydromorphic fields and ponds) (Ribeiro & Fernandes 2000). Several studies have shown the floristic richness of the quartzite rock outcrops of Serra da Mantiqueira, and we highlight systematic surveys conducted in the regions of Ibitipoca and Serra Negra in Minas Gerais state (Forzza *et al.* 2013; Salimena *et al.* 2013). However, studies concerning the wetlands of these environments are still incipient, both in ecological aspects and floristic composition. Brazil is still far from obtaining a detailed survey of its wetlands, which is a prerequisite for building a coherent national policy for sustainable management and protection of these areas, where a lack of national wetlands classification that considers hydrological conditions and plant communities is one of the fundamental problems (Nunes da Cunha *et al.* 2015).

The floristic and structural surveys of Brazilian wetlands reveal their importance regarding species diversity and richness. Wetlands are essential in groundwater recharge, surface water storage and filtration, biogeochemical cycles and local climate regulation, as well as habitats for several species (Esteves 1998; Lee *et al*. 2015). However, they are constantly threatened by direct anthropogenic actions, mainly due to deforestation and urban and agricultural hydrographic basin use, which can generate disastrous consequences even when they are in conservation units (Meirelles *et al*. 2002).

Due to the lack of knowledge about montane wetlands, especially in rocky quartzite outcrops, surveys are extremely relevant as an instrument to be utilized in evaluation and planning of management actions. Thus, this study is intended to fill a gap in the knowledge on the Brazilian montane wetlands vegetation and Parque Estadual do Ibitipoca wetlands flora. We also seek to identify the relationships and particularities of its flora in relation to richness, floristic composition and life forms.

Material and Methods

Study site

The Parque Estadual do Ibitipoca (PEIB) (21°40'–21°44'S, 43°52'–43°55'W, 1,000–1,784 m) is a conservation unit located between municipalities of Minas Gerais state, Bias Fortes, Lima Duarte and Santa Rita do Ibitipoca, and inserted in the Mantiqueira range. The park covers 1,488 hectares within the Atlantic Forest domain and has quartzite rock outcrops (*campos rupestres*) as its main vegetation formation (Vitta 2002; Menini Neto & Salimena 2013; Oliveira-Filho *et al.* 2013). The local climate is Cwb according to the Köppen classification, which indicates a well-defined precipitation cycle: cold and dry winter (April to September) and rainy summer (October to March). The annual average rainfall is approximately 2,248 mm at 1,350 m, and the average temperature is 18.9 °C with a minimum of 4 °C (Rodela & Tarifa 2002; Rocha 2013).

The vegetation can be interpreted as a mosaic of forested areas, grasslands and wetlands with high diversity and endemism (Oliveira-Filho *et al*. 2013). The grasslands occupy the second largest area of the park, with 22.4% of the total, occurring on clay soils or slabs and quartzite cliffs (Oliveira-Filho *et al*. 2013). This physiognomy includes subdivisions such as dry quartzite rock outcrops and moist quartzite rock outcrops (wetlands), controlled by the soil depth and flooding periodicity (Dias *et al*. 2002).

The wetlands in the park are represented by moist grasslands and one seasonal pond. The areas are small but enough to sustain a seasonal and predictable flood from October to March (rainy season). In this season, the moist grasslands have superficial flooding with a maximum depth of 10 cm. This vegetation occurs disjointed and interspersed with the dry quartzite rock outcrops (Fig. 1a). During the drought, it is possible to distinguish the dry quartzite rock outcrops by

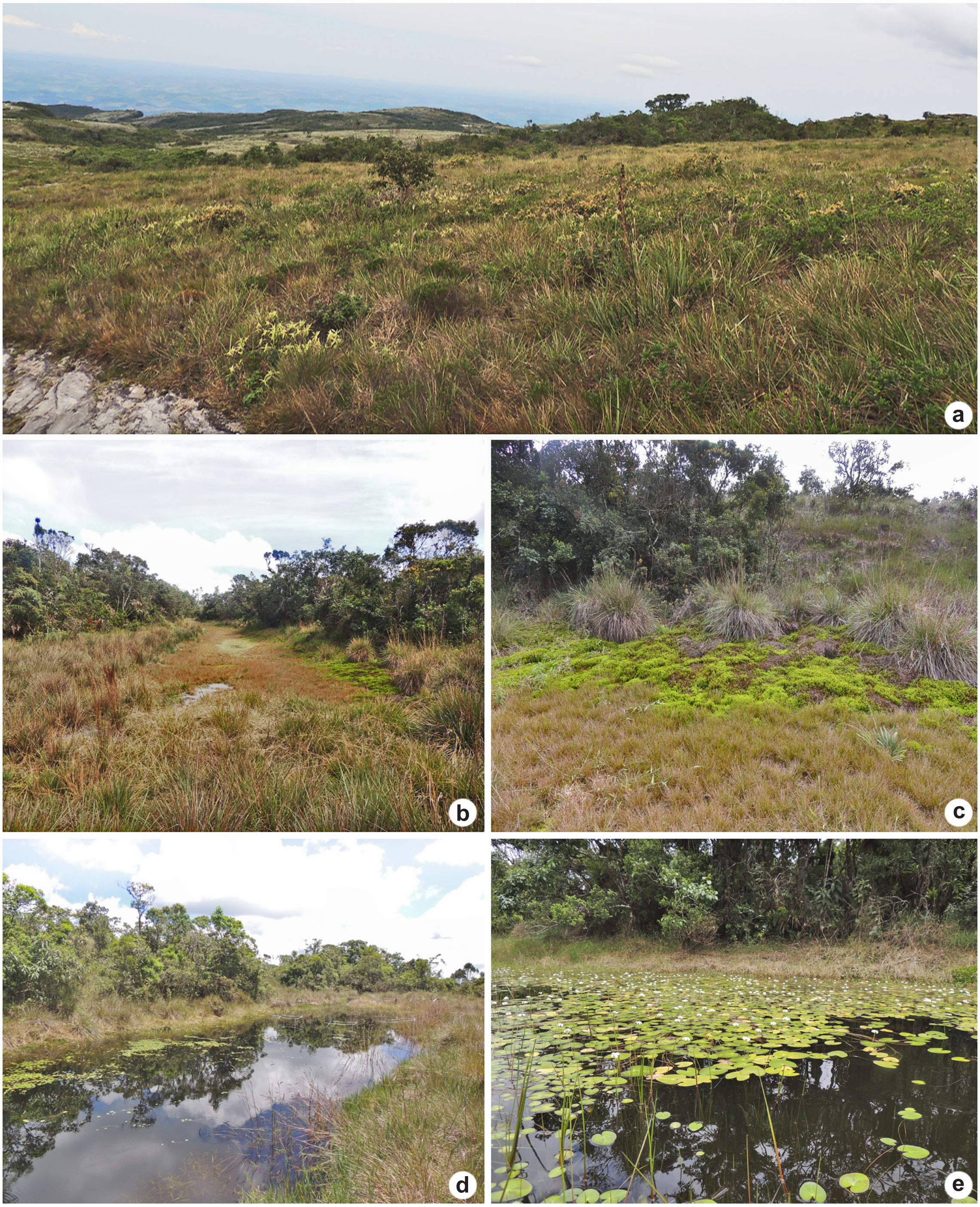

Figure 1 – a-e. Wetlands of the Parque Estadual do Ibitipoca – a. moist grasslands; b-e. seasonal pond (*lagoa seca*) – b-c. dry season; d-e. rainy season.

the soil darkness and the presence of bryophytes species covering a great part of the surface. The seasonal pond (Fig. 1b-e), locally named Lagoa seca is a closed depression that accumulates water during the rainy season due to the rainfall and superficial groundwater oscillation, with a maximum depth of 1 m (Fig. 1d-e). It is surrounded by cloud forests and is distinct from the moist grasslands by the presence of species which are completely adapted to aquatic life.

Inventory

Sixteen trips to the study areas were carried out for 12 months (2015–2016). We selected four areas of moist grasslands located at the west part of the park, between 1,560 to 1,760 m (Tab. 1). Systematic exploration was conducted in the moist grasslands and seasonal pond to survey the flora. The checklist also included samples previously collected in the PEIB' wetlands that were deposited in the herbarium of Universidade Federal de Juiz de Fora (CESJ) and identified by specialists. Collection and herborization followed the usual techniques for vascular plants (Fidalgo & Bononi 1989) and the vouchers were incorporated into the CESJ. Identification was performed using specialized bibliography with comparisons to the CESJ collection and by consulting specialists. The classification of families followed the Angiosperm Phylogeny group (APG IV 2016) and the authors and species names were checked at BFG (2018). The species were grouped into the following life form classes: phanerophytes, chamaephytes, geophytes (terrestrial cryptophytes), hydrophytes (aquatic cryptophytes), hemicryptophytes, therophytes and lianas (Raunkiaer 1934; Braun-Blanquet 1979).

The conservation status of the species at national levels followed the CNCFlora (2018) database. Species endemism and distributions were obtained from BFG (2018) and taxonomic reviews. We additionally identified alien species based on the Base de Dados Nacional de Espécies Exóticas Invasoras I3N Brasil (Instituto Hórus 2018).

Table 1 – Location and altitude of the wetlands study area in Parque Estadual do Ibitipoca.

Locality	Altitude (m)	Coordinates	
		Latitude	Longitude
Moist grassland 01	1760	-21º41'19.86"	-43º53'30.91"
Moist grassland 02	1692	-21º41'25.78"	-43º53'35.62"
Moist grassland 03	1595	-21º41'35.39"	-43º53'41.06"
Moist grassland 04	1568	-21º41'41.31"	-43º53'45.23"
Seasonal pond	1633	-21º40'55.72"	-43º52'22.75"

Results

We recorded 148 specimens, representing 102 species of vascular plants distributed in 69 genera and 25 families in the PEIB wetlands, including a new species for science (Tab. 2).

Eighty-one (81) angiosperm species were found in the moist grasslands, representing 55 genera and 21 families. The most representative families were Asteraceae (22 species), Melastomataceae (nine spp.), Xyridaceae (seven spp.), Orchidaceae and Poaceae (six spp. each). These families account for about 62% of the sampled species. The genus *Xyris* presented the highest specific representativeness (seven spp.), followed by *Mikania* and *Baccharis* (four spp. each). Twenty-seven (27) species were recorded at the seasonal pond, representing 23 genera and 11 families. Poaceae was the most representative (eight spp.), followed by Cyperaceae and Asteraceae (five spp. each), accounting for nearly 67% of the sampled species. The genus with the highest specific representativeness was *Andropogon* (three spp.), followed by *Baccharis* and *Bulbostylis* (two spp. each). Among the sampled genera, 74% are represented by only one species. About 70% of the recorded species have worldwide distribution. Some taxa have been found only in the studied area, not occurring in other areas of the park.

Table 2 – List of species collected in the wetlands of the Parque Estadual do Ibitipoca, Minas Gerais, Brazil, indicating: Voucher (CESJ); Location (MG = moist grasslands, SP = seasonal pond); Conservation Status (NA = not assessed; SD = slightly disturbing; AT = almost threatened; VU = vulnerable; EN = endangered); Life form (LF) (PHA = phanerophyte; CAM = chamaephyte; HEM = hemicryptophyte; GEO = geophyte; HYD = hydrophyte; TER = terophyte; LI = liana and Endemism). The species highlighted with (*) represent those endemics to Brazil; underlined are endemic to Minas Gerais state; (**§**) are new records for the park; and (?) new species. In parentheses, ahead of the family name are the numbers of genera and species of each family.

Family / Species	Voucher (CESJ)	Location		*Status*	LF
		MG	SP		
Alstroemeriaceae (1/1)					
Alstroemeria isabelleana Herb.	L.V.V. Cruz *et al.* 71	x		NA	GEO
Amaryllidaceae (1/1)					
Hippeastrum glaucescens (Mart.) Herb.	L.V.V. Cruz *et al.* 75	x		NA	GEO
Apocynaceae (2/3)					
Ditassa linearis Mart. *	L.V.V. Cruz *et al.* 152	x		AT	LI
Oxypetalum lanatum Decne. *ex* E.Fourn. *	L.V.V. Cruz *et al.* 136	x		NA	LI
Oxypetalum minarum E.Fourn. *	L.V.V. Cruz *et al.* 64	x		NA	LI
Asteraceae (13/25)					
Ageratum fastigiatum (Gardner) R.M.King & H.Rob.	L.V.V. Cruz *et al.* 26		x	NA	TER
Baccharis crispa Spreng. DC.	L.V.V. Cruz *et al.* 44	x	x	NA	PHA
Baccharis itatiaiae Wawra *	L.V.V. Cruz *et al.* 78	x		NA	PHA
Baccharis cf. pingraea DC. **§**	L.V.V. Cruz *et al.* 82	x		NA	PHA
Baccharis platypoda DC. *	L.V.V. Cruz *et al.* 150	x		NA	PHA
Baccharis rufidula (Spreng.) Joch.Müll. *	L.V.V. Cruz *et al.* 45		x	NA	PHA
<u>*Chionolaena arbuscula*</u> DC. *	L.V.V. Cruz *et al.* 112	x		NA	HEM
<u>*Chionolaena lychnophorioides*</u> Sch.Bip. * **§**	F.M. Ferreira *et al.* 1011	x		VU	HEM
Chromolaena ascendens (Baker) R.M.King & H.Rob. *	M.A. Heluey *et al.* 29	x		NA	HEM
Cyrtocymura scorpioides (Lam.) H.Rob. * **§**	M.A. Heluey *et al.* 88	x		NA	PHA
Heterocondylus pumilus (Gardner) R.M.King & H.Rob. *	L.V.V. Cruz *et al.* 68	x		SD	CAM
Lepidaploa cf. helophila (Mart. *ex* DC) H. Rob *	L.V.V. Cruz *et al.* 134	x		NA	CAM
Lessingianthus minimus Dematt. *	M.A. Heluey 16	x		NA	GEO
Lessingianthus psilophyllus (DC.) H.Rob. *	M.A. Heluey 59	x		NA	GEO
Mikania decumbens Malme *	L.V.V. Cruz *et al.* 138	x	x	AT	LI
Mikania lindbergii Baker. *	M.A. Heluey *et al.* 84	x		SD	LI
Mikania nummularia DC. *	L.V.V. Cruz *et al.* 18	x		NA	CAM
Mikania testudinaria DC. *	L.V.V. Cruz *et al.* 174	x		NA	LI
Senecio adamantinus Bong. *	L.V.V. Cruz *et al.* 116	x		SD	HEM

Family / Species	**Voucher (CESJ)**	**Location**		***Status***	**LF**
		MG	**SP**		
Senecio emiliopsis C.Jeffrey *	M.A. Heluey *et al.* 70	x		NA	HEM
Stenophalium chionaeum (DC.) Anderb. *	L.V.V. Cruz *et al.* 69	x		NA	CAM
Stevia urticaefolia Thunb.	L.V.V. Cruz *et al.* 153	x		NA	HEM
Vernonanthura westiniana (Less.) H.Rob. *	L.V.V. Cruz *et al.* 95		x	NA	CAM
Asteraceae sp.1	L.V.V. Cruz *et al.* 145	x		-	CAM
Asteraceae sp.2	L.V.V. Cruz *et al.* 151	x		-	TER
Begoniaceae (1/1)					
Begonia rufa Thunb. *	L.V.V. Cruz *et al.* 146	x		SD	TER
Campanulaceae (3/3)					
Lobelia hilaireana (Kanitz) E.Wimm. *	L.V.V. Cruz *et al.* 147	x		EN	PHA
Siphocampylus westinianus (Thunb.) Pohl *	L.V.V. Cruz *et al.* 76	x		NA	GEO
Wahlenbergia brasiliensis Cham. *	L.V.V. Cruz *et al.* 43	x		NA	PHA
Cyperaceae (6/9)					
Bulbostylis capillaris (L.) C.B.Clarke §	L.V.V. Cruz *et al.* 23		x	NA	HEM
Bulbostylis junciformis (Kunth.) C.B.Clarke * §	L.G. Rodela 3A-10	x		NA	HEM
Bulbostylis juncoides (Vahl) Kük. *ex* Osten §	L.V.V. Cruz *et al.* 22		x	NA	HEM
Cryptangium junciforme (Kunth) Boeckeler *	L.V.V. Cruz *et al.* 79	x		NA	HEM
Cyperus rigens C.Presl	L.V.V. Cruz *et al.* 5		x	NA	HEM
Eleocharis sp. nov. ? §	L.V.V. Cruz *et al.* 27		x	-	HEM
Lagenocarpus rigidus Nees	L.V.V. Cruz *et al.* 70	x		NA	HEM
Rhynchospora polyantha Steud. §	L.V.V. Cruz *et al.* 20		x	NA	HEM
Rhynchospora tenuis Link	L.V.V. Cruz *et al.* 140	x		SD	HEM
Droseraceae (1/2)					
Drosera montana A.St.-Hil.	L.V.V. Cruz *et al.* 29	x		NA	HEM
Drosera villosa A.St.-Hil. *	L.V.V. Cruz *et al.* 111	x		NA	HEM
Eriocaulaceae (4/5)					
Comanthera nivea (Bong.) L.R.Parra & Giul. *	L.V.V. Cruz *et al.* 144	x		NA	TER
Leiothrix flavescens (Bong.) Ruhland	L.V.V. Cruz *et al.* 110	x		NA	HEM
Paepalanthus elongatus (Bong.) Koern. *	L.V.V. Cruz *et al.* 137	x		NA	GEO
Paepalanthus itatiaiensis Ruhland * §	L.V.V. Cruz *et al.* 80	x		NA	HEM
Syngonanthus costatus Ruhland *	L.V.V. Cruz *et al.* 129	x	x	NA	TER
Euphorbiaceae (1/1)					
Euphorbia chrysophylla (Klotzsch & Garcke) Boiss. §	L.V.V. Cruz *et al.* 143	x		NA	TER
Fabaceae (1/1)					

Family / Species	Voucher (CESJ)	Location		***Status***	LF
		MG	SP		
Centrosema coriaceum Benth. *	L.V.V. Cruz *et al.* 86		x	NA	LI
Gentianaceae (1/1)					
Calolisianthus pedunculatus (Cham. & Schltdl.) Gilg *	L.V.V. Cruz *et al.* 149	x		NA	TER
Haloragaceae (1/1)					
Laurembergia tetrandra (Schott) Kanitz §	L.V.V. Cruz *et al.* 96		x	SD	HYD
Iridaceae (1/1)					
Sisyrinchium vaginatum Spreng.	L.V.V. Cruz *et al.* 163	x		NA	GEO
Juncaceae (1/1)					
Juncus microcephalus Kunth §	L.V.V. Cruz *et al.* 7		x	NA	HEM
Lamiaceae (1/1)					
Eriope macrostachya Mart. *ex* Benth.	L.V.V. Cruz *et al.* 92	x	x	SD	HEM
Lentibulariaceae (1/2)					
Utricularia laciniata A.St.-Hil. & Girard *	L.V.V. Cruz *et al.* 122	x		NA	HEM
Utricularia triloba Benj.	L.V.V. Cruz *et al.* 121	x		NA	HEM
Melastomataceae (8/9)					
Chaetostoma armatum (Spreng) Cogn. *	M.A. Heluey *et al.* 2	x		NA	PHA
Lavoisiera imbricata (Thunb.) DC. *	L.V.V. Cruz *et al.* 142	x		SD	PHA
Leandra aurea (Cham.) Cogn.	L.V.V. Cruz *et al.* 84	x		NA	PHA
Marcetia taxifolia (A.St.-Hil.) DC. *	L.V.V. Cruz *et al.* 175	x		NA	PHA
Miconia sellowiana Naudin *	M.A. Heluey *et al.* 30	x		NA	PHA
Microlicia serpyllifolia D.Don *	F.R.G. Salimena *et al.* 3860	x		NA	PHA
Siphanthera arenaria (DC.) Cogn. *	L.V.V. Cruz *et al.* 12	x	x	NA	HEM
Pleroma collina (Naud.) Triana *	M.A. Heluey *et al.* 53	x		NA	PHA
Pleroma semidecandra (Schrank & Mart. *ex* DC.) Triana *	L.V.V. Cruz *et al.* 148	x		NA	PHA
Menyanthaceae (1/1)					
Nymphoides humboldtiana (L.) Kuntze	L.V.V. Cruz *et al.* 9		x	NA	HYD
Orchidaceae (5/6)					
Gomesa barbaceniae (Barb.Rodr.) M.W.Chase & N.H.Williams *	L.V.V. Cruz *et al.* 114	x		SD	HEM
Epidendrum dendrobioides Thunb.	L.V.V. Cruz *et al.* 115	x		SD	HEM
Epidendrum secundum Jacq.	L.V.V. Cruz *et al.* 16	x		SD	CAM
Gomesa warmingii (Rchb.f.) M.W.Chase & N.H.Williams	L.V.V. Cruz *et al.* 81	x		NA	HEM
Habenaria rolfeana Schltr. *	F.R.G. Salimena *et al.* 3864	x		NA	GEO
Zygopetalum maculatum (Kunth) Garay	L.V.V. Cruz *et al.* 141	x		SD	GEO

Family / Species	**Voucher (CESJ)**	**Location**		***Status***	**LF**
		MG	**SP**		
Poaceae (8/13)					
Andropogon bicornis L.	L.V.V. Cruz *et al.* 15		x	NA	HEM
Andropogon lateralis Nees	L.V.V. Cruz *et al.* 10		x	NA	HEM
Andropogon leucostachyus Kunth	L.V.V. Cruz *et al.* 120	x	x	NA	HEM
Andropogon macrothrix Trin.	L.V.V. Cruz *et al.* 132	x		NA	HEM
Apochloa euprepes (Renvoize) Zuloaga & Morrone *	L.V.V. Cruz *et al.* 131	x		NA	HEM
Axonopus fastigiatus (Nees *ex* Trin.) Kuhlm.	M.A. Heluey *et al.* 92	x		VU	HEM
Axonopus polystachyus G.A. Black *	L.V.V. Cruz *et al.* 8		x	NA	HEM
Axonopus siccus (Nees) Kuhlm.	M.A. Heluey *et al.* 63	x		NA	HEM
Chascolytrum calotheca (Trin.) Essi, Longhi-Wagner & Souza-Chies	L.V.V. Cruz *et al.* 25		x	NA	HEM
Danthonia secundiflora J.Presl	L.V.V. Cruz *et al.* 21		x	NA	HEM
Dichanthelium surrectum (Chase *ex* Zuloaga & Morrone) Zuloaga	L.V.V. Cruz *et al.* 24		x	SD	HEM
Melinis minutiflora P.Beauv.	L.V.V. Cruz *et al.* 30		x	NA	HEM
Trichanthecium cyanescens (Nees *ex* Trin.) Zuloaga & Morrone	M.A. Heluey *et al.* 61	x		NA	HEM
Polygalaceae (2/2)					
Caamembeca oxyphylla (DC.) J.F.B.Pastore * §	L.V.V. Cruz *et al.* 72	x		NA	TER
Polygala cneorum A.St.-Hil. & Moq. *	L.V.V. Cruz *et al.* 130	x		NA	HEM
Primulaceae (1/2)					
Myrsine gardneriana A.DC.	L.V.V. Cruz *et al.* 162	x		NA	PHA
Myrsine glazioviana Warm. *	L.V.V. Cruz *et al.* 135	x		EN	PHA
Rubiaceae (3/3)					
Borreria capitata (Ruiz & Pav.) DC.	L.V.V. Cruz *et al.* 13		x	NA	HEM
Coccocypselum glabrifolium Standl. *	L.V.V. Cruz *et al.* 89	x		NA	CAM
Galianthe brasiliensis (Spreng.) E.L.Cabral & Bacigalupo	L.V.V. Cruz *et al.* 14		x	NA	CAM
Xyridaceae (1/7)					
Xyris augusto-coburgii Szyszył. *ex* Beck *	L.V.V. Cruz *et al.* 77	x		SD	HEM
Xyris cf. fusca L.A.Nilsson * §	L.V.V. Cruz *et al.* 139	x		EN	HEM
Xyris graminosa Pohl *ex* Mart. *	F.R.G. Salimena *et al.* 3866	x		NA	HEM
Xyris cf. hymenachne Mart.	F.R.G. Salimena *et al.* 3865	x		NA	HEM
Xyris cf. seubertii L.A.Nilsson §	L.V.V. Cruz *et al.* 113	x		NA	HEM
Xyris trachyphylla Mart. *	F.R.G. Salimena *et al.* 1320	x		SD	HEM
Xyris cf. tortula Mart. *	F.R.G. Salimena *et al.* 3861	x		NA	HEM

About 15% of the sampled species are new records for the park (Tab. 2). Beyond that, only five species are common to both areas (5.1% of the species richness). The richness found in the PEIB wetlands is expressive, despite the small size of the areas (Tab. 3).

The hemicryptophyte life form was the most representative in both areas, representing nearly 43% of the moist grasslands flora and 63% of the seasonal pond. At the moist grasslands phanerophytes represent about 21% of the species found, followed by geophytes (11%), chamaephytes and therophytes (9% each), and finally lianas (7%); whereas in the seasonal pond phanerophytes, hydrophytes, therophytes, chamaephytes and lianas have approximately 7% of species each (Fig. 2).

Table 3 – Comparison of altitude, area and species richness among wetland studies. AF = Atlantic Forest; S = Savanna.

Reference	Wetlands type	Domain	Altitude (m)	Area (ha)	Richness
Present study	Seasonal pond	AF	1633	0.108	27
Present study	Moist grasslands	AF	1560-1760	0.19	81
Meyer & Franceschinelli 2010 *	Ponds	S/AF	1000	0.25	224
Magalhães *et al.* 2013	"Banhados"	AF	800-1600	1	143
Munhoz & Felfili 2006	Moist grasslands	S	1482	21	207

* Altitude not quoted directly at work. Mean of the altitudes found for the sites presented in the study.

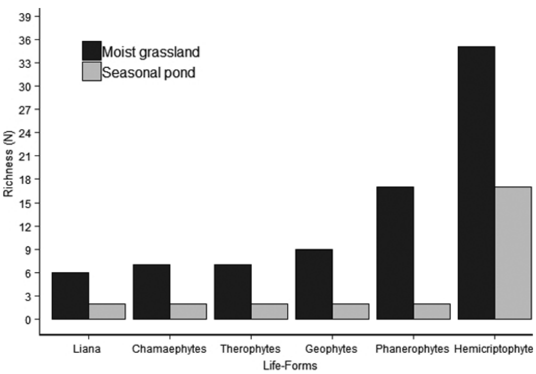

Figure 2 – Species richness according to life-form spectra of the wetlands of Parque Estadual do Ibitipoca.

Discussion

The representativeness of Asteraceae in the moist grasslands is expected for open areas, since they provide the ideal conditions of high luminosity intensity, for their establishment (Tannus & Assis 2004; Amaral *et al*. 2013). Poaceae and Cyperaceae stand out in the seasonal pond because part of its representatives are perennials and have similar ecological characteristics, propagating efficiently and dominating the environment both in flood and periods of low water column (Bove *et al*. 2003). In addition, Cyperaceae species act as monocot ridge mats, increasing the environment heterogeneity according to the availability of water and mechanical support, thus facilitating the next successional steps (Barthlott *et al*. 1993; Meirelles 1996).

In general, the sampled families are well represented in other floristic surveys in the *complexos rupestres* and other Brazilians wetlands, such as the *banhados* wetlands in Santa Catarina state (Magalhães *et al*. 2013; Silva *et al*. 2013a), wetlands in Rio Grande do Sul (Bertoluci 2004; Boldrini *et al*. 2008; Rolon *et al*. 2010), Mato Grosso do Sul (Moreira *et al*. 2011) Goiás (Munhoz & Felfili 2006, 2007) states, and other seasonal wetlands (Bertuzzi 2013). Moreover, the sampled families resemble what was found by Meyer & Franceschinelli (2010) in quartzite rock outcrops wetlands at the Cadeia do Espinhaço range.

The richest sampled genera (*Xyris*, *Mikania*, *Baccharis*, *Andropogon* and *Bulbostylis*) are common in swampy areas, rivers, lakes, grasslands and montane vegetation: *Xyris* has a Pantropical distribution such as *Mikania*, which also has Minas Gerais state as one of its diversity centers (Ritter & Miotto 2005). *Baccharis* has a Pan-American distribution, with high richness in the Andes. Moreover, it also occurs in other Brazilian grasslands (Borges & Forzza 2008). Both *Andropogon* and *Bulbostylis* have Tropical distribution and are very common in other Brazilian wetlands (Dias-Melo *et al*. 2009; Rolon & Maltchik 2006).

The PEIB wetlands have distinct and singular floristic composition, probably due to floristic association with the adjacent physiognomy, that may act as a species pool due its proximity, and the different levels of flooding. The cloud forests that surround the seasonal pond and the area declivity together create a flood of more than 1 m of depth, leading to species submersion. On the other hand, the water depth in the moist grasslands does not exceed 10 cm. The temporary submersion of the seasonal pond species may be acting as an environmental filter and contributing to a smaller colonization of the species from the dry grasslands, and consequently resulting in the occurrence of species that only exist in that area, such as the new Cyperaceae species.

Regarding other recent surveys in altitudinal wetlands, it was not possible to observe an association between species richness and altitude (Tab. 3). Although the widely known concept that a decline in species richness occurs with altitude due to the lower nutrients availability and smaller rates of nitrogen mineralization and nitrification (Marrs *et al*. 1988), studies that contemplate this relation are rare in wetlands (Rolon & Maltchik 2006). In the present work, it was possible to show that there are altitudinal wetlands with considerable richness showing an important composition to conservation, despite its size. It is possible to see a tendency to increase in species number in relation to an increase in the sampled area, except for the work by Meyer & Franceschinelli (2010), probably for sampling lacustrine environments and wetlands adjacent to rivers, considering the surrounding flora extending up to 2.5 m from the shore. These findings corroborate the results of Vestergaard & Sand-Jensen (2000), which show that species richness is more related to colonization area over the wetland's total surface area. According to Rolon & Maltchik (2006), altitude and size are factors that influence species richness in flooded systems or swamps and are not significant in lacustrine systems.

Hemicryptophyte species show major facility in surviving in hydric stressed environments and are related to altitude fields and Brazilian savanna moist grasslands (*e.g.*, Caiafa & Silva 2005; Tannus 2007). These species are mostly perennials and capable of resisting the unfavorable seasons of nutritional deficits occurring in the *complexos rupestres* and the seasonal water level fluctuation. This resistance is mainly due to different metabolic, physiologic and morphologic patterns existent for surviving anoxic and undernourished periods (Keddy & Reznicek 1986; Campbell *et al*. 2016). In contrast, annual or terophyte species have minor occurrence in both areas due to germination which only occurs when the water level decreases and are capable to temporarily explore friendlier spots. These species only establish when they can complete their life cycles rapidly, with seeds protected by the soil (Keddy & Reznicek 1986; Martins & Batalha 2001). The altitude could also contribute to the proportion of hemicryptophyte life forms. There is a decrease of annual species as the altitude increase in forests in China at an altitudinal gradient of 1,400 to 2,800 m, and the inverse occurs for perennial species (Wang *et al*. 2002).

The moist grasslands flora is mostly composed of endemic species from Brazil (approximately 56%), with twelve of them being endemic to Minas Gerais state. In addition, 25 taxa have neotropical distribution. The predominance of endemic species is very unusual for wetlands due to clonal reproduction, high dispersion rates and the plasticity of its species (Santamaría 2002). The occurrence of the great number of endemic species in the PEIB moist grasslands not typical from flooded places may be explained by the occasional occurrence of some of them, that are generally found in other physiognomies in the park. Furthermore, the predictable flood pulse promotes the development of adaptations and endemism, with some organisms benefitting during the wet season, and others during the dry season (Nunes da Cunha *et al*. 2015). In addition, the convergence in species adaptations in quartzite rock outcrops also contributes to the occurrence of endemic species (Alves & Kolbek 1994; Giulietti *et al*. 1987; Porembski & Barthlott 2000).

About 22% of the richness are at some national threatened degree (CNCFlora 2018), among which we may highlight: *Ditassa linearis* as "threatened" conservation status, *Chinolaena lychnophorioides* as "vulnerable" and *Lobelia hilaireana*, *Myrsine glazioviana* and *Xyris cf. fusca* as "endangered".

Melinis minutiflora was the only alien species recorded in the PEIB wetlands. Despite the minor presence of alien species in the PEIB wetlands, the frequency of *Melinis minutiflora* in the seasonal pond is noteworthy. This species has African origin and was probably introduced in the PEIB through livestock grazing before the implantation of this conservation unit (Salimena-Pires 1997). It is very common in anthropized areas, as well as close to trails (Dias-Melo *et al*. 2009; Herrera *et al*. 2016) and has an efficient vegetative growth, easily dispersing to several locations. Dense clumps are formed in the seasonal pond at the water edges throughout the year. Its presence could work as a barrier hampering the arrival and germination of native seeds and the recruitment of seedlings (Hughes & Vitousek 1993). The occurrence of alien species is a concerning issue due to its aggressiveness and capability of excluding native species by competing for resources. Moreover, *M. minutiflora* is capable to deprive the vegetation physiognomy in a few years (Martins *et al*. 2009; Silva *et al*. 2013b).

The new Cyperaceae species belongs to *Eleocharis* R. Br. *subgenus Scirpidium*. This subgenus occurs in subtropical regions or in high American altitudes such as the Andes. This would be the most tropical sample for the subgenus (Rafael Trevisan, personal communication). The most related species are *Eleocharis radicans* (Poir.) Kunth, found in the midwest, south and southeast of Brazil and in altitude fields; *Eleocharis tucumanensis* Barros and *Eleocharis exigua* (Kunth) Roem & Schult., exclusively in the Andes. This taxon has a great frequency in the seasonal pond with restricted occurrence to this site, which emphasizes the local importance for the taxon conservation, which may be considered micro endemic.

Although some of the sampled species also occur in other areas of the PEIB, the capability of established on the wetlands may be due some adaptation to a flooded environment. Thus, our work suggests that flooding acts as a filter to colonization in the PEIB wetlands, probably related to species submersion, generating differences in the most abundant life forms. In addition, the low number of shared species between both wetlands reaffirms the great physiognomic disparity with the presence of unique characteristics between them.

Quartzite rock outcrop edaphic patterns and flood amplitudes resulted in great floristic composition with conservation importance due to the presence of endemic species to Brazil and Minas Gerais state, endangered species, and a new species for science. However, it is important to highlight that the occurrence of *Melinis minutiflora* in the seasonal pond is of concern.

Thus, with all the known diversity and endemism for the Serra da Mantiqueira, especially on quartzite rock outcrops and a lack of knowledge from the floristic point of view of its wetlands, it is extremely important to continue working in these unique, rich and special environments, especially to better understand the plant colonization and establishment in these environments.

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