

Vascular grassland plants of Tibagi River Spring, Ponta Grossa, Brazil

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ABSTRACT: A systematic survey was carried out on wet grasslands found over Histosols at Upper Tibagi River basin, between Ponta Grossa and Palmeira municipalities, in the state of Paraná, Brazil, place of high importance because of soil water retention capability and soil carbon pool composition. We provide a checklist containing 146 species, 96 genera and 42 plant families for the area. Families with higher species richness were Asteraceae (27 species; 21 genera), Poaceae (24; 16) and Cyperaceae (18; 6). Four species were classified as endangered or rare, and one as exotic. The specific richness in wet grassland environments at the state of Paraná underlines the need for conservation efforts encompassing these formations.

INTRODUCTION

The most important Rivers of the state of Paraná – Brazil, have their springs located at high altitudes (540 to 1,680 m a.s.l., MINEROPAR 2006), where low temperatures (-7.8 to 2°C, Maack 1981) and high annual rainfall (1,300 to 3,470 mm/year, Maack 1981) usually predominate, like Serra do Mar, Escarpa Devoniana or 1st cuesta (geomorphological shape between 1st and 2nd Paraná plateau) and Serra Geral or 2nd cuesta (geomorphological shape between 2nd and 3rd Paraná plateau).

Among these Rivers, the Tibagi presents various springs inserted in the dip slopes of the 1st cuesta (higher altitude), many of them under diffuse water flux in Histosols.

The *Organossolos* (Santos *et al.* 2006), resembling Histosols by Soil Survey Staff (2006), are soils located in reliefs that promote water saturation (Birkeland 1999), usually acid, with high cation exchange capacity (CEC), low nutrient availability (Breemen 1995) and low base saturation, with eventual average to high base saturation (Santos *et al.* 2006; Valladares *et al.* 2008) and large amounts of exchangeable aluminum. Pedogenesis in these soils are related to a water table level near the soil surface, with no important changes along the year, under anoxic conditions, which reduces the organic matter mineralization, thus promoting the storage of carbon-rich organic matter complexes (Santos *et al.* 2006; Sá 2007) and favouring pedogenetic processes.

Herb species predominate along areas covered by hydric soils, into high relief plateaus (wet grasslands) (Gates 1915; Breemen 1995; Costa *et al.* 2003). Besides the studies found in Costa *et al.* (2003), Cervi *et al.* (2007) and Kozera *et al.* (2009), little information is available regarding areas with similar abiotic conditions. Floristic studies of wet grasslands do not encompass only organic soils, but also mineral hydric soils. Costa *et al.* (2003) and Cervi *et al.* (2007) studied the floristic composition of floodplains with different chemical and physical soil features, which affect vegetation. Kozera *et al.* (2009)

worked in grassland formations near our study area and presented a large species list, classified according to the amount of water present in soils, although lacking any soil composition analyses.

In these peat-bogs environments, an association between vascular plants and *Sphagnum* spp. (besides other mosses) is observed, alongside the presence of special conditions like chemical and physical soil features, soil water storage and water table level that favour the establishment of some species. According Costa *et al.* (2003), the floristic richness found in these areas is conditioned by relief and water table level.

The Histosols have a broad geographic distribution along the cuestas of the state of Paraná, and have important environmental functions such as carbon storage, hydrologic regulation and potential nutrient-absorbing capacity. Furthermore, when vegetation is focused, these soil types encompass a large and unique genetic diversity, threatened by inadequate management that exhausts soil capability. Despite the importance of these environments, their floristic richness is scarcely known. The present work presents a checklist of herb and shrub species that occur in Histosols at Tibagi River Spring.

MATERIALS AND METHODS

The study area is located in the dip slope of 1st cuesta of state of Paraná (Escarpa Devoniana), inserted over Furnas sandstone, with elevation of 1,096 m a.s.l. The area comprises the region locally known as Campos Gerais, specially Tibagi River Spring (25°16'25" S, 49°49'29" W), between Ponta Grossa and Palmeira municipalities – PR (Figure 1), approximately 90 km from Curitiba, the state capital.

The climate is Cfb (altitudinal sub-tropical humid) according to Köppen classification, with mean annual temperature between 20 and 22 °C (Cruz 2003), and average yearly rainfall of 1,550 mm (Stipp *et al.* 2000).

The area is inserted in a flat surface (a slightly

concave relief), where Histosols or *Organossolos Háplicos* predominate due to genetic processes such as accumulation of organic material, especially herb species and bryophytes. In order to analyze floristic composition, we sampled 0.65 ha (115 x 57 m) from September 2008 to November 2009, in fortnightly field expeditions. The site is constantly grazed by sheep and cattle, a common situation in most natural grasslands in southern Brazil.

In each field expedition we collected botanical material according to the method described in Filgueiras *et al.* (1994). Surveys encompassed the same soil order, in areas with hydric conditions ranging from a water table located near the surface (a usual condition within this soil order) to a water table rather distant from the surface, a condition promoted by gully erosion that have altered local hydrological regimes. The gully erosion is present in one among the several geological faults in the area as observed in Figure 1.

We collected and preserved plant material from all vascular plant species found within the study area, preferably with reproductive structures. Vouchers for each species were deposited at MBM Herbarium, and a duplicate of each was sent to UPCB Herbarium.

Towards a better understanding of this environment, we carried out a preliminary survey of moss species present in the study area. Since a thorough survey encompassing mosses would probably result in higher species richness, we excluded the species we found from the presented checklist, although they are mentioned in our results.

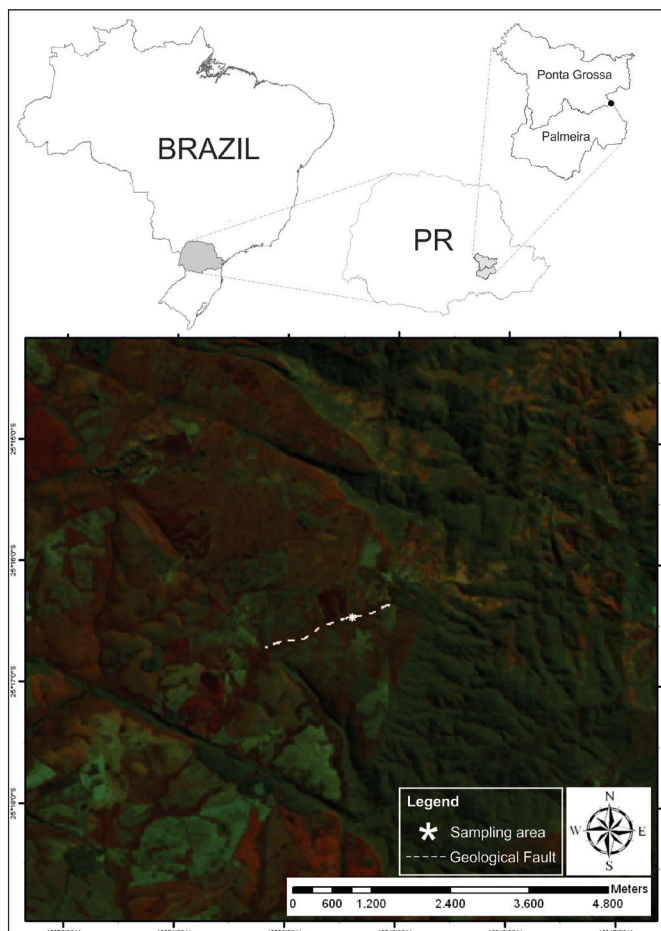


FIGURE 1. Map location of Tibagi River Spring (black dot) in the state of Paraná and in Brazil, and Landsat 5TM image of study area.

For species taxonomic classification, we followed Tryon and Tryon (1982) and Smith *et al.* (2006) for Pterydophyta and Angiosperm Phylogeny Group III (APG III 2009) for angiosperms. We researched valid plant names in electronic databases of World checklists (Kew 2008; especially for monocots), Missouri Botanical Garden website (MOBOT 2008) and The International Plant Names Index website (IPNI 2008). Citation of author names follows Brummit and Powell (1992) and Pichi-Sermolli (1996).

We evaluated the presence of extinction-threatened species in the study area through revision of extinction-threatened species lists (Hatschbach and Ziller 1995; IBAMA 1992 and MMA 2008). The presence of exotic plant species was evaluated through revision of a local governmental list (IAP 2009).

The floristic similarity between these data, Kozera (2008) and Costa *et al.* (2003), were calculated using Sorensen index. This analysis was carried out using software MULTIV beta (Pillar 2006).

RESULTS AND DISCUSSION

We recorded 146 grassland taxa (132 angiosperms and 14 ferns) distributed in 42 families (Table 1). One taxon was identified only at the family level, five at the generic level. In order to achieve a better understanding of environment conditions at the study area, four moss species, were accounted for a preliminary survey: *Sphagnum oxyphyllum* Warnst. and *Sphagnum recurvum* P. Beauv. (Sphagnaceae), *Pogonatum pensylvanicum* (Hedw.) P. Beauv. and *Polytrichum commune* L. (Polytrichaceae).

Families with the highest species number were Asteraceae, Poaceae and Cyperaceae. The same result was verified in other floristic and phytosociological surveys in Southern Brazil, both in hydric (Kozera *et al.* 2009; Setubal and Boldrini 2010) and non-hydric soils (Buselato and Bueno 1981; Boldrini and Miotto 1987; Zocche and Porto 1992).

Poaceae plays a key role defining landscapes along the study area, due to the abundance of cespituous species such as *Andropogon leucostachyus*, *Paspalum flaccidum* and *Leptocoryphium lanatum*. Cyperaceae is recognized as a characteristic family of wet tropical environments (Goetghebeur 1998; Alves *et al.* 2008), and was significantly represented by *Cyperus* and *Rhynchospora*. Asteraceae showed an important physiognomic value, especially due to the shrub *Baccharis crispa*.

No Fabaceae species were found, probably due to the waterlogged condition. Similarly, Kozera *et al.* 2009 and Costa *et al.* 2003 found only one Fabaceae species in their surveys, both carried out in similar waterlogged conditions. On the other hand, in surveys carried out under well-drained mineral soils, Fabaceae was among the richest families (Boldrini and Miotto 1987; Boldrini and Eggers 1996; Boldrini *et al.* 1998; Setubal and Boldrini 2010).

We observed dominance of tropical species, but there were also many temperate species like *Briza calotheca*, *Danthonia montana* and *Piptochaetium montevidense*. Herb species predominated along this evaluation, and most shrubs belong to Asteraceae, Clusiaceae, Ericaceae, Melastomataceae, Scrophulariaceae and Solanaceae. Also, we observed tree species (*Myrsine cf. gardneriana*

and *Rhamnus sphaerosperma* Sw.), both configuring uncommon plant species in wet grasslands, according to Tannus and Assis (2004), since the organic matter accumulation under anoxic conditions is a limiting condition for the establishment of trees. The occurrence of these species is probably related to the presence of gully erosion, which altered soil features, and can be interpreted as an indicative of poor environmental quality.

TABLE 1. Vascular grassland plants present at Tibagi River Spring, Ponta Grossa, Brazil.

FAMILIES/SPECIES	HABIT
APIACEAE	
<i>Eryngium ebracteatum</i> L.	herb
<i>Eryngium horridum</i> Malme	herb
<i>Eryngium subinerme</i> Mathias and Constance	herb
<i>Hydrocotyle leucocephala</i> Cham. and Schldtl.	herb
ASTERACEAE	
<i>Achyrocline alata</i> (Kunth) DC.	herb
<i>Achyrocline satureioides</i> (L.) DC.	herb
<i>Ageratum conyzoides</i> Sieber ex Steud.	herb
<i>Austroeupatorium laete-virens</i> (Hook. and Arn.) R.M. King and H. Rob.	shrub
<i>Baccharis ramboi</i> G. Heiden and L. Macias	shrub
<i>Baccharis crispa</i> Spreng.	shrub
<i>Baccharis megapotamica</i> Spreng.	shrub
<i>Baccharis stenocephala</i> Baker	shrub
<i>Barrosoa betoniciformis</i> (DC.) R.M. King and H. Rob.	shrub
<i>Bidens pilosa</i> L.	herb
<i>Campovassouria cruciata</i> (Vell.) R.M. King and H. Rob.	shrub
<i>Erechtites valerianifolius</i> (Wolf) DC.	herb
<i>Gnaphalium purpureum</i> L.	herb
<i>Grazielia multifida</i> (DC.) R.M. King and H. Rob.	herb
<i>Holocheilus hieracioides</i> (D. Don) Cabrera	herb
<i>Hypochaeris brasiliensis</i> (Less.) Benth. and Hook. f. ex Griseb.	herb
<i>Hypochaeris lutea</i> Britton	herb
<i>Jungia floribunda</i> Less.	herb
<i>Leptostelma maximum</i> D. Don	herb
<i>Mikania micrantha</i> Kunth	herb
<i>Pluchea oblongifolia</i> DC.	herb
<i>Senecio grossidens</i> Dusén	herb
<i>Solidago microglossa</i> DC.	herb
<i>Trixis brasiliensis</i> (L.) DC.	herb
<i>Trixis lessingii</i> DC.	herb
<i>Vernonanthura westiniana</i> (Less.) H. Rob.	shrub
<i>Vernonia elegans</i> Gardner	herb
BEGONIACEAE	
<i>Begonia fischeri</i> Schrank	herb
BLECHNACEAE	
<i>Blechnum cordatum</i> (Desv.) Hieron.	herb
<i>Blechnum polypodoides</i> Raddi	herb

TABLE 1. CONTINUED.

FAMILIES/SPECIES	HABIT
<i>Blechnum schomburgkii</i> (Klotzsch) C. Chr.	herb
CAMPANULACEAE	
<i>Lobelia exaltata</i> Pohl	herb
<i>Lobelia nummularioides</i> Cham.	herb
CARYOPHYLLACEAE	
<i>Drymaria</i> sp.	herb
CLUSIACEAE	
<i>Hypericum brasiliense</i> Choisy	shrub
CYATHEACEAE	
<i>Cyathea phalerata</i> Mart.	herb
CYPERACEAE	
<i>Cyperus aggregatus</i> (Willd.) Endl.	herb
<i>Cyperus haspan</i> L.	herb
<i>Cyperus hermaphroditus</i> (Jacq.) Standl.	herb
<i>Cyperus impolitus</i> Kunth	herb
<i>Cyperus incomtus</i> Kunth	herb
<i>Cyperus reflexus</i> Vahl	herb
<i>Eleocharis squamigera</i> Svenson	herb
<i>Eleocharis nudipes</i> (Kunth) Palla	herb
<i>Fimbristylis complanata</i> (Retz.) Link	herb
<i>Kyllinga odorata</i> Vahl	herb
<i>Kyllinga pumila</i> Michx.	herb
<i>Rhynchospora</i> aff. <i>corymbosa</i> (L.) Britton	herb
<i>Rhynchospora emaciata</i> (Nees) Boeck.	herb
<i>Rhynchospora marisculus</i> Lindl. ex Nees	herb
<i>Rhynchospora globosa</i> (Kunth) Roem. and Schult.	herb
<i>Rhynchospora</i> aff. <i>polyantha</i> Steud.	herb
<i>Rhynchospora rigida</i> (Kunth) Boeck.	herb
<i>Scleria hirtella</i> Sw.	herb
DICKSONIACEAE	
<i>Dicksonia sellowiana</i> Hook.	herb
DROSERACEAE	
<i>Drosera communis</i> A. St.-Hil.	herb
DRYOPTERIDACEAE	
<i>Deparia petersenii</i> (Kunze) M.Kato	herb
ERICACEAE	
<i>Agarista chlorantha</i> (Cham.) G. Don	shrub
<i>Gaylussacia pseudogaultheria</i> Cham. and Schldtl.	shrub
ERIOCAULACEAE	
<i>Eriocaulon ligulatum</i> L.B. Sm.	herb
<i>Eriocaulon sellowianum</i> Kunth	herb
<i>Leiothrix flavescens</i> (Bong.) Ruhland	herb
<i>Paepalanthus caldensis</i> Malme	herb
<i>Paepalanthus catharinae</i> Ruhland	herb
<i>Syngonanthus caulescens</i> (Poir.) Ruhland	herb
EUPHORBIACEAE	
<i>Euphorbia elodes</i> Boiss.	herb

TABLE 1. CONTINUED.

FAMILIES/SPECIES	HABIT
GESNERIACEAE	
<i>Sinningia elatior</i> (Kunth) Chautems	herb
GLEICHENIACEAE	
<i>Dicranopteris flexuosa</i> (Schrad.) Underw.	herb
HYPOXIDACEAE	
<i>Hypoxis decumbens</i> L.	herb
IRIDACEAE	
<i>Gelasine coerulea</i> (Vell.) Ravenna	herb
<i>Sisyrinchium</i> sp.	herb
<i>Sisyrinchium vaginatum</i> Spreng.	herb
JUNCACEAE	
<i>Juncus</i> cf. <i>densiflorus</i> Kunth	herb
<i>Juncus</i> cf. <i>effusus</i> L.	herb
<i>Juncus microcephalus</i> H.B.K.	herb
<i>Juncus</i> aff. <i>tenuis</i> Willd.	herb
LAMIACEAE	
Lamiaceae sp.	herb
<i>Rhabdocaulon lavanduloides</i> (Benth.) Epling	herb
<i>Hyptis fasciculata</i> Benth.	herb
LENTIBULARIACEAE	
<i>Utricularia tricolor</i> A. St.-Hil.	herb
<i>Utricularia praelonga</i> St. Hil. and Girard	herb
LILIACEAE	
<i>Nothoscordum bonariense</i> (Pers.) Beauverd	herb
LINACEAE	
<i>Linum littorale</i> A. St.-Hil.	herb
LYCOPODIACEAE	
<i>Lycopodiella</i> sp.	herb
MAYACACEAE	
<i>Mayaca</i> sp.	herb
MELASTOMATACEAE	
<i>Leandra eichleri</i> Cogn.	shrub
<i>Rhynchanthera brachyrhyncha</i> Cham.	herb
<i>Tibouchina cerastifolia</i> Cogn.	herb
<i>Tibouchina gracilis</i> (Bonpl.) Cogn.	herb
<i>Tibouchina ursina</i> Cogn.	shrub
MYRSINACEAE	
<i>Myrsine</i> cf. <i>gardneriana</i> A. DC.	tree
ORCHIDACEAE	
<i>Cyanaeorchis arundinae</i> (Rchb. f.) Barb. Rodr.	herb
<i>Habenaria parviflora</i> Lindl.	herb
OSMUNDACEAE	
<i>Osmunda regalis</i> L.	herb
POACEAE	
<i>Agrostis longiberbis</i> Hack. ex L.B. Sm.	herb
<i>Andropogon lateralis</i> Nees	herb
<i>Andropogon leucostachyus</i> Kunth	herb

TABLE 1. CONTINUED.

FAMILIES/SPECIES	HABIT
<i>Andropogon macrothrix</i> Trin.	herb
<i>Andropogon virgatus</i> Desv. ex Ham.	herb
<i>Axonopus affinis</i> Chase	herb
<i>Axonopus polystachyus</i> G.A. Black	herb
<i>Briza calotheca</i> (Trin.) Hack.	herb
<i>Calamagrostis</i> sp.	herb
<i>Danthonia montana</i> Döll	herb
<i>Hemarthria altissima</i> (Poir.) Stapf and C.E. Hubb.	herb
<i>Leptocoryphium lanatum</i> (Kunth) Nees	herb
<i>Otachyrium versicolor</i> (Döll) Henrard	herb
<i>Panicum sabulorum</i> L.	herb
<i>Panicum schwackeanum</i> Mez	herb
<i>Panicum surrectum</i> Chase ex Zuloaga and Morrone	herb
<i>Paspalum cordatum</i> Hack.	herb
<i>Paspalum flaccidum</i> Nees	herb
<i>Paspalum polyphyllum</i> Nees ex Trin.	herb
<i>Piptochaetium montevidense</i> (Spreng.) Parodi	herb
<i>Rhynchacne rottboellioides</i> Desv. ex Ham.	herb
<i>Saccharum asperum</i> (Nees) Steud.	herb
<i>Schizachyrium condensatum</i> (Kunth) Nees	herb
<i>Stipa</i> sp.	herb
POLYGALACEAE	
<i>Polygala longicaulis</i> Kunth	herb
<i>Polygala tenuis</i> DC.	herb
POLYPODIACEAE	
<i>Pleopeltis hirsutissima</i> (Raddi) de la Sota	herb
PTERIDACEAE	
<i>Adiantopsis chlorophylla</i> (Sw.) Fée	herb
<i>Doryopteris lomariacea</i> (Kunze) Klotzsch	herb
RHAMNACEAE	
<i>Rhamnus sphaerosperma</i> Sw.	tree
ROSACEAE	
<i>Acaena eupatoria</i> Cham. and Schltldl.	herb
RUBIACEAE	
<i>Galium equisetoides</i> (Cham. and Schltldl.) Standl.	herb
<i>Spermacoce</i> cf. <i>verticillata</i> L.	herb
<i>Spermacoce</i> sp.	herb
SCROPHULARIACEAE	
<i>Buddleja elegans</i> Cham. and Schltldl.	shrub
<i>Scoparia elliptica</i> Cham.	herb
SELAGINELLACEAE	
<i>Selaginella marginata</i> (Humb. and Bonpl. ex Willd.) Spring	herb
SOLANACEAE	
<i>Solanum americanum</i> Mill.	herb
<i>Solanum pseudocapsicum</i> L.	shrub
<i>Solanum reflexum</i> Schrank	herb
<i>Solanum sisymbriifolium</i> L.	herb

TABLE 1. CONTINUED.

FAMILIES/SPECIES	HABIT
<i>Solanum viarum</i> Dunal	shrub
THELYPTERIDACEAE	
<i>Thelypteris rivularioides</i> (Fée) Abbiatti	herb
XYRIDACEAE	
<i>Xyris filifolia</i> A. Nilsson	herb
<i>Xyris laxifolia</i> Mart.	herb
<i>Xyris neglecta</i> Alb. Nilsson	herb
<i>Xyris regnelli</i> Nilsson	herb
<i>Xyris stenophylla</i> Alb. Nilsson	herb

Four species are present in the list of threatened species of the state of Paraná (Hatschbach and Ziller 1995) and also in the Brazilian Federal list of threatened species (MMA 2008): *Baccharis megapotamica* Spreng. (Asteraceae), *Cyanaeorchis arundinae* (Rchb. f.) Barb. Rodr. (Orchidaceae), *Paepalanthus catharinae* Ruhland (Eriocaulaceae) and *Dicksonia sellowiana* Hook. (Dicksoniaceae). The first two were classified as rare and the last two as endangered. The first three species highlight the urgent need for conservation efforts encompassing similar areas, associated to programs that promote good management of nearby protected areas. The presence of *Dicksonia sellowiana*, an uncommon species in wet grasslands, was probably a result of soil water balance alterations promoted by gully erosion. The presence of the exotic species *Deparia petersenii* (Kunze) M. Kato (Dryopteridaceae), would suggest a potential impact on grassland habitats.

Floristic similarity between the present study and Kozera et al. (2009) and Costa et al. (2003) was respectively 32.3% and 5.2 %, whereas similarity between these two studies was 10.8%. The higher similarity observed between this study and Kozera et al. (2009) is probably due to the geographic location (second plateau of State of Paraná). The number of sampled species is probably another factor that leads to the differences observed among the studies: Kozera et al. (2009) found 175 species (*Cyperus virens* Michx. and *C. intricatus* Schrad ex. Schult were considered synonyms), whereas Costa et al. (2003) found 47 species (*Sphagnum* sp. was not considered in the analysis). The study area of Costa et al. (2003) and Kozera et al. (2009) covered also hydric soils, but probably under organic and inorganic soil. Therefore, these authors sampled soils with different chemical and physical soil features, which probably influenced the vegetation composition.

Over the last years, grasslands in state of Paraná had their original extension reduced with the substitution of natural vegetation by crops. Even in a small sampling area, we recorded an species-rich vegetation, so we consider these vegetation data useful for supporting the elaboration of public conservation policies concerning the remaining natural areas and, moreover, efforts aiming the restoration of disturbed places.

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