Check List 9(5): 973–979, 2013

ISSN 1809-127X (available at *www.checklist.org.br*)

Check List
Journal of species lists and distribution

Lists of Species

Flora of Brazilian humid Chaco: Composition and reproductive phenology

Tiago Green de Freitas [1], Camila Silveira de Souza [1], Camila Aoki [2], Luan Marcell Mitsuo Arakaki [1], Thiago Henrique Stefanello [1], Ângela Lúcia Bagnatori Sartori [1] and Maria Rosângela Sigrist [1*]

1 Universidade Federal de Mato Grosso do Sul, Centro de Ciências Biológicas e da Saúde, Departamento de Biologia. CEP 79070-900. Campo Grande, MS, Brazil.
2 Universidade Federal de Mato Grosso do Sul, Campus Universitário de Aquidauana, CPAQ, Departamento de Biociências. Avenida Oscar Trindade de Barros 740, Unidade II, Serraria. CEP 79200-000. Aquidauana, MS, Brazil.
* Corresponding author. Email: *sigristster@gmail.com*

Abstract: We present the floristic composition and reproductive phenological data for a remnant of Arborized Stepic Savanna, vegetation type of humid Chaco, Porto Murtinho, Mato Grosso do Sul State, Brazil. We recorded 87 species of 31 families; Leguminosae presented the highest richness (14 species), followed by Malvaceae (9), Cactaceae (7) and Asteraceae (7). The herbaceous layer is relevant in the seasonal studied community (53.5% of the species) and there is predominance of non-perennial species (hemicryptophytes and therophytes), which demonstrate the importance of underground structures or seed banks in the vegetation. The community has continual flowering and fruiting with highest intensity in the rainy season, the most favorable period for plant growth and reproduction. The predominance of autochoric species in relation to anemochoric and zoochoric ones suggests partial independence of seed/fruit dispersal agents. Zoochorous species predominated in the rainy season, whereas anemochorous and autochorous species were more representative in the dry season.

Introduction

Chaco or "Gran Chaco" is the term applied to seasonal vegetation that covers the vast plains of north-central Argentina, south-eastern Bolivia, western Paraguay and Brazil, totaling about 800.000 km^2 (Prado 1993). In general the Chaco is divided into an eastern sector, with a more humid climate, and a western, drier sector, whilst the submeridional lowlands include a large depression between these two areas (Bianchi and Gibbs 2000). Chaquean vegetation is mainly formed by shrubs, spiny, deciduous and microphyllous, usually associated with saline soils (Silva *et al.* 2000). In Brazil, Chaco vegetation is restricted to the western border of Mato Grosso do Sul State, in Porto Murtinho (Silva and Abdon 1998; Pennington *et al.* 2000).

Despite occupying immense territorial area, there are relatively very few studies that recorded floristic and phenological data for the Chaco vegetation. In Argentina there is information on the herbaceous and woody flora from central Chaco (Zak and Cabido 2002; Cagnolo *et al.* 2006) and south regions (Marino and Pensiero 2003). In Brazil there is a floristic survey for one community (Nunes 2006) and only one study reporting tree species (Noguchi *et al.* 2009) in the most common forest types at Brazilian Chaco vegetations. Flowering phenodynamics is available for wild cucurbit (*Cucurbita maxima* ssp. *ondreono*) (Ashworth and Galetto 2001) and 43 Asteraceae species co-occurring in natural populations in central Argentina (Torres and Galetto 2011). Reproductive phenology of eight species with zoochorous diaspores was studied by Marco and Páez (2002) in central Argentina, and Noguchi *et al.* (2009) investigated fruit type and dispersal syndromes of tree species in some Brazilian Chaco vegetations.

We present a checklist of the flowering plants recorded in a remnant of Arborized Stepic Savanna, a vegetation type of humid Brazilian Chaco. Additionally we characterize the habit, life form and dispersal syndrome of the ascertained species and present some reproductive phenological data for the community and the species.

Materials and Methods

Data collection was made montlhy in a remnant of humid Chaco (Arborized Stepic Savanna), in the Pantanal, sub-region of Porto Murtinho (Silva and Abdon 1998), Porto Murtinho municipality, Mato Grosso do Sul State (MS) (21°42'04"S, 57°53'06"W), from August 2010 to September 2011 (Figure 1). The Chaco climate is marked by strong seasonality, with hot summer with maximum temperature reaching 49° C, and dry and cold winter, with occasional frost. During the rainy season, temporary flooding may occur due to the poor drainage of the compact soil (Pennington *et al.* 2000). In the study area, rainy season occurs from November to February (rainfall ≥ 100mm) and dry season starts in April, becoming more pronounced from June to September, when water deficit occurs. Transition season occurs in March-May (from rainy to dry) and October (from dry to rainy), when there is no recorded water deficit, and rainfall reaches over 100 mm (Figure 2).

The floristic and phenological surveys were performed along five fixed transects, each about 200m long. All plants in reproductive phase within three meters of each side of the transect line were sampled. Samples of plant species were collected, identified and deposited in the CGMS Herbarium of Universidade Federal de Mato Grosso do Sul (UFMS). The identification of the plant species was made through comparison with specimens from CGMS Herbarium and with the support of specialists/

taxonomists. Families follow Angiosperm Phylogeny Group (APG III 2009). For the phenological studies, plants were evaluated considering presence or absence of buds, flowers (flowering) and fruits (immature, mature or fruiting). Classification of habits and life forms of plant species was made according to Guedes-Bruni *et al.* (2002) and Raunkiaer (1934 *apud* Radford *et al.* 1974), respectively. Dispersal syndromes were categorized according to Pijl (1982). Duration of flowering and fruiting phenology was classified according to Newstrom *et al.* (1994) in brief (< 1 month), intermediate (>1 month and <5 month) or extended (>5 month).

Results and Discussion

We recorded 87 species belonging to 31 families. Leguminosae presented the highest richness (14 species), followed by Malvaceae (9), Cactaceae (7) Asteraceae and Bromeliaceae (6 spp. each); the other families contributed with one to five species (Table 1). Leguminosae is one of the most representative families of the flora of Mato Grosso do Sul (Dubs 1998) and also presents high richness in different vegetation formations, including the Chaco (Alves and Sartori 2009; Noguchi *et al*. 2009).

Herbaceous species predominated (53.5% of the species) in relation to subshrubs (21.0%), trees (16.3%), epiphytes (5.8%) and lianas (3.4%). The herbaceous layer is able to recycle critical nutrients, dislocating them from underground organs (Monasterio and Sarmiento 1976). This fact associated with high efficiency in water use and high temperature optimizes photosynthesis, resulting in competitive success (Monasterio and Sarmiento 1976). Together, hemicryptophytes and therophytes (31.4% each) accounted for more than half of the studied species in the community, followed by chamaephytes (16.3%),

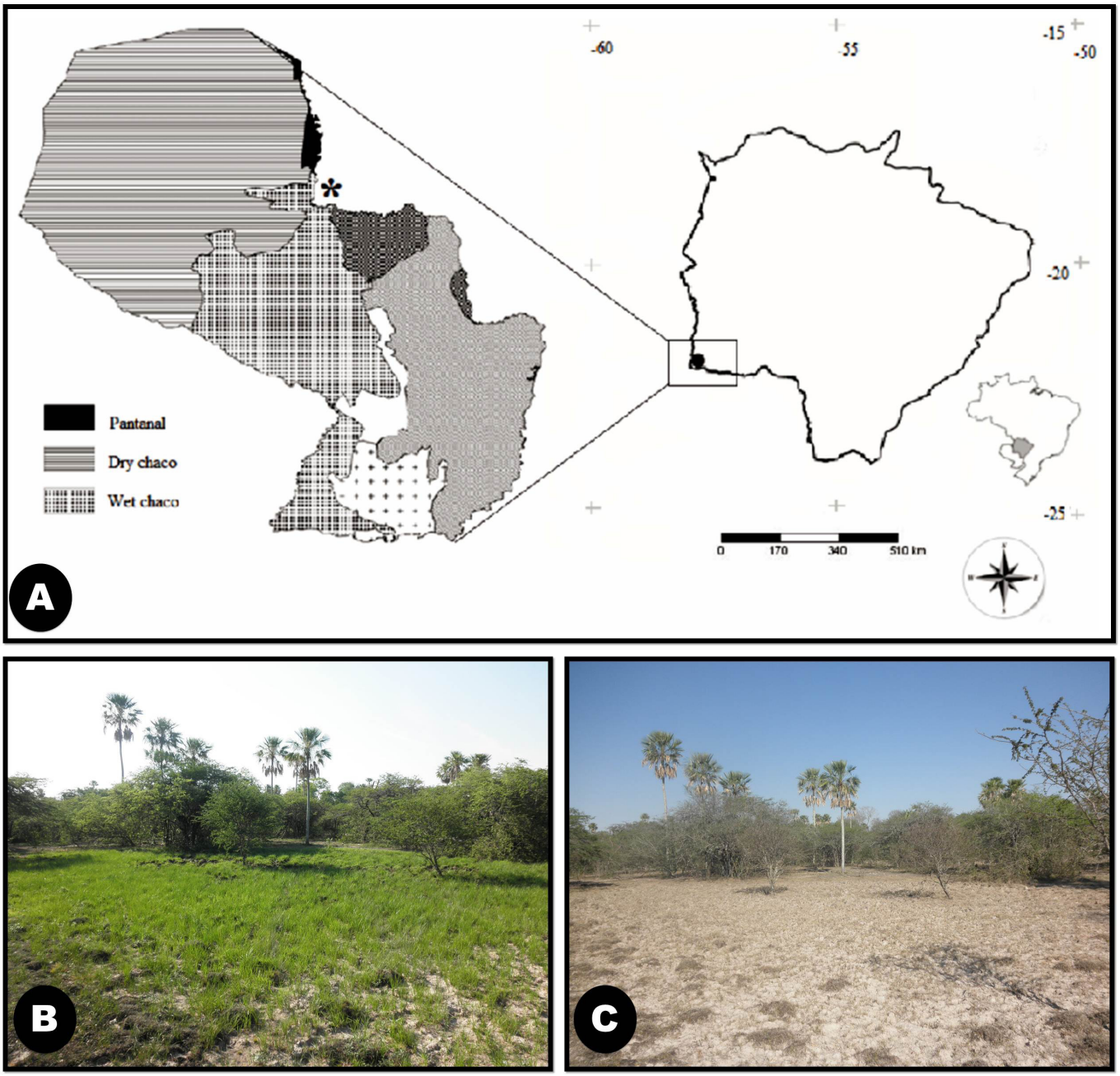

Figure 1. Major ecoregions of Paraguay neighboring Brazil and the municipality of Porto Murtinho, greatly associated with Wet Chaco, a Chaco biome (modified from Souza et al. 2010), *Municipality of Porto Murtinho, Mato Grosso do Sul State, Brazil (A). View of vegetation in wet (B) and dry (C) seasons in a remnant of Arborized Stepic Savanna, a vegetation type of humid Chaco of Brazil.

phanerophytes (15.1%) and geophytes (5.8%) (Table 1). The predominance of hemicryptophytes, therophytes and geophytes demonstrates the importance of underground structures or seed banks in the community as a strategy for maintenance of species in the environment during periods of water stress (Rebellato and Cunha 2005).

The studied community presented species blooming and fructifying during the whole study period (Figure 3A) and therefore the pattern of flowering and fruiting of the community is continual (*sensu* Newstrom *et al.* 1994). This fact is also observed in several studies in Cerrado vegetation (e.g. Batalha and Mantovani 2000; Batalha and Martins 2004; Munhoz and Felfili 2007).

Almost half the community presented flowering with intermediate duration (49.3%) followed by brief (37.4%) and extended (13.3%). Predominance of intermediate flowering is recorded in seasonal vegetations such as "cerrado" (Batalha *et al.* 1997) and mountain savanna ("campo rupestre") (Dutra *et al.* 2009). Flowering was most intense in the rainy season, with marked reduction in the dry season (figure 3A), a pattern that was also observed in other seasonal vegetations such as Cerrado physiognomies (e.g. Batalha *et al.* 1997; Mantovani and Martins 1988; Munhoz and Felfili 2005). In the rainy season, the environmental conditions were more favorable, especially to herbaceous species, which predominate in this study. In environments marked by seasonality, water is available mainly in deep soil layers (Franco 2002), and herbaceous plants which have shallow roots (Ogle and Reynolds 2004) concentrate reproduction in the rainy season, while woody species, mainly trees, may reproduce even during the dry season (Monasterio and Sarmiento 1976; Batalha *et al.* 1997; Munhoz and Felfili 2005, 2007; Tannus *et al.* 2006).

Brief fructification (45.8%) predominated in the studied community, followed by intermediate (32.2%) and extended (22.0%) frutification (Table 1). Predominance of brief and intermediate fructification can be associated with short rainy season in the studied region (four months), and along with the high number of herbaceous species observed, the fructification of species is concentrated in moist periods (Castillo and Carabias 1982). It also demonstrates the importance of vegetative propagation for herbaceous species, which occupy the place due to their underground reserves (Mantovani and Martins 1988; Batalha and Mantovani 2000). In herbaceous and woody species, during the driest months, the highest proportion of anemochoric and autochoric frutification is observed compared to zoochoric (Mantovani and Martins 1988; Batalha *et al*. 1997) These fruits are generally dry and dehydrated to release their seeds (Batalha and Mantovani 2000). Under seasonal climate, anemochory is more efficient in the dry season (Augspurger and Franson 1987).

Highest intensity of fructification occurred during the whole rainy season and also in part of the transition season (from rainy to dry) (figure 3A). In seasonal environments, species tend to synchronize fruiting and dispersal with the onset of the rainy season to maximize seedling development and establishment, and species that disperse fruit in the dry season tend to have seed dormancy (Oliveira 1998; Felfili *et al.* 1999).

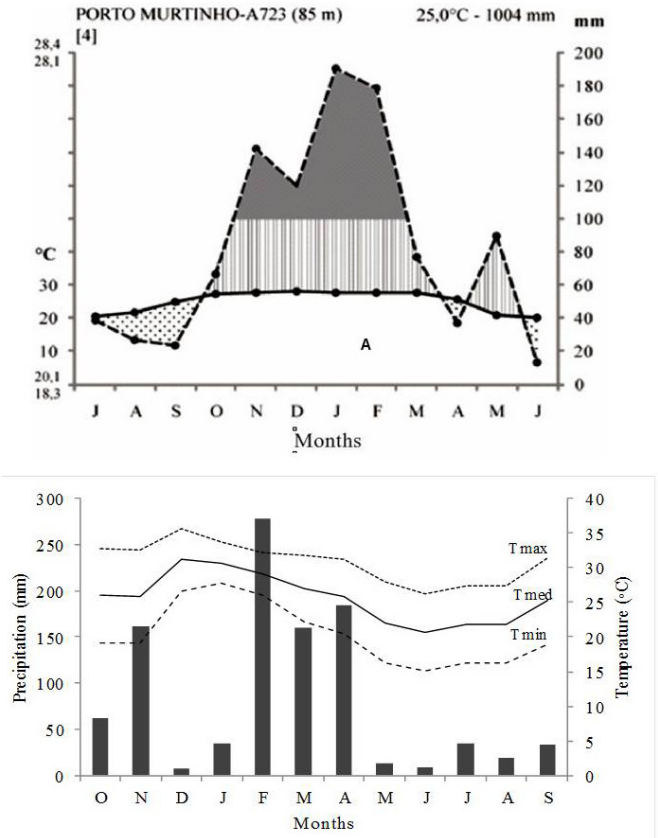

Figure 2. Climate diagrams of Porto Murtinho region, Mato Grosso do Sul State (MS): (A) climate diagram (Walter 1986) of Porto Murtinho, from 2006 to 2010; (B) distribution of accumulated precipitation (bars) and mean temperature (lines) during the study period (October/2010 to September/2011). Tmax = mean of maximum temperature; Tmed = average temperature; Tmin = mean of minimum temperature. Source: Centro de Monitoramento do Tempo, Clima e Recursos Hídricos de MS (CEMTEC).

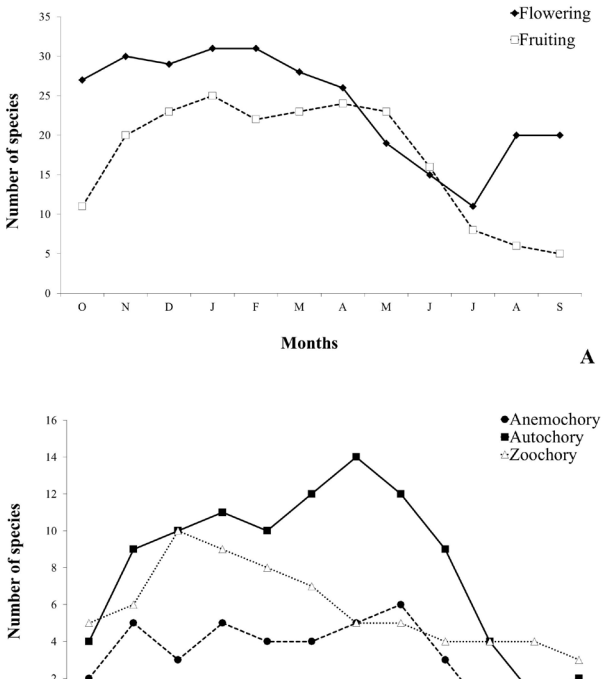

Figure 3. Richness of flowering and fruiting species (A) and distribution of three types of seed dispersal syndromes (B) in a remnant of Arborized Stepic Savanna, a vegetation type of humid Chaco, Mato Grosso do Sul State, Brazil, from October/2010 to September/2011.

Autochory predominated (65.5%) in relation to anemochory and zoochory (17.25% each) (Table 1) similar to the dispersal observed in other open vegetation formations (Oliveira and Moreira 1992; Vieira *et al.* 2002). All these types of dispersal syndromes were recorded during the whole study period (except anemochory in July) (Figure 3B). Zoochorous species had a better representation in the rainy season (mainly December), whereas anemochorous and autochorous species predominated during transitional and dry season, mainly May and April, respectively (figure 3B). Autochoric and anemocoric fruits tend to be produced generally in the driest periods when dispersion could be more efficient (Oliveira and Moreira 1992; Morellato and Leitão-Filho 1996; Batalha and Martins 2004). Dry fruits may be favored by Chaco physiognomy that consists mostly of Arborized Stepic Savanna, which is an open area (Noguchi *et al*. 2009).

Herbaceous layer is important in the seasonal studied community and there is predominance of short-perennial and annual species (e.g. hemicryptophytes, therophytes, geophytes) which demonstrate the importance of underground structures or seed banks for the community. The studied community has continual flowering and fruiting, but with highest intensity in the rainy season, the most favorable period for plant growth and reproduction. The predominance of autochoric species suggests partial independence on seed/fruit dispersal agents.

Table 1. Habit, life form and characteristics of flowering and fruiting phenology of the plant species sampled in a remnant of humid Chaco (Arborized Stepic Savanna), Porto Murtinho municipality, Mato Grosso do Sul State, Brazil, from August 2010 to June 2011. Habit: A = arboreal, H = herbaceous, L = liana, S= subshrubby, E= epiphyte; Life forms: Ch = chamaephyte, Ph= phanerophyte, Ge = geophyte, He = hemicryptophyte, Te = therophyte; Duration: Inter = intermediate; Dispersal syndrome = ANEMO = anemochory; AUTO = autochory, ZOO = zoochory; ind. = indetermined.; CGMS = Herbarium CGMS; n° = number.

SPECIES	Habit	Life form	FLOWERING			FRUTIFICATION				CGMS
			Season		Duration	Season		Duration	Dispersal	record
			Dry	Wet	(n° months)	Dry	Wet	(n° months)	syndrome	n°
Acanthaceae										
Justicia clivalis Wassh.	H	Te	X		brief (1)	ind.	ind.	brief (1)	AUTO	35255
Justicia laevilinguis (Nees) Lindau	H	Te	X		inter (2)	ind.	ind.	inter (2)	AUTO	35447
Ruellia tweediana Griseb.	H	He		X	brief (1)	ind.	ind.	brief (1)	AUTO	35277
Apocynaceae										
Rhabdadenia pohlii Müll. Arg.	H	Te		X	brief (1)	X	X	ind.	AUTO	36891
Asclepiadaceae										
Asclepiadaceae 1	A	Te	X		brief (1)	X		ind.	AUTO	35473
Amaranthaceae										
Alternanthera sp.	H	He	X	X	inter (5)	X		extended (8)	ANEMO	35444
Froelichia procera (Seub. and Mart.) Pedersen	H	He	X		inter (3)	X		inter (3)	AUTO	35263
Gomphrena celosioides Mart.	H	Te	X		brief (1)	X	X	brief (1)	AUTO	35445
Gomphrena elegans Mart.	H	Te		X	brief (1)	X		brief (1)	AUTO	35419
Pfaffia glomerata (Spreng.) Pedersen	H	He	X	X	inter (4)	ind.	ind.	inter (3)	AUTO	35224
Anacardiaceae										
Astronium sp.	A	Ph	X		inter (2)	X		inter (4)	ZOO	36878
Asteraceae										
Eupatorium sp.	H	Te	X		brief (1)	X	X	ind.	AUTO	35436
Pectis gardneri Baker	H	Te		X	brief (1)	X	X	inter (7)	ANEMO	35462
Lepidaploa muricata (DC.) H.Rob.	H	Te	X	X	extended (11)	ind.	ind.	extended (8)	ANEMO	35265
Soliva sp.	H	Te	X		brief (1)	ind.	ind.	brief (1)	ANEMO	36889
Sphagneticola trilobata (L.) Pruski.	H	Te	X	X	inter (3)			brief (1)	ANEMO	35449
Vernonia sp.	H	Te	X	X	extended (11)	ind.	ind.	extended (8)	ANEMO	35446
Bignoniaceae										
Tabebuia nodosa (Griseb.) Griseb.	A	Ph	X	X	inter (4)		X	inter(2)	ANEMO	37104
Boraginaceae										
Cordia glabrata (Mart.) A.DC.	A	Ph	X	X	inter (2)		X	brief (1)	ANEMO	36879
Bromeliaceae										
Bromelia balansae Mez	S	He		X	inter (3)		X	extended (12)	ZOO	37106
Bromelia hieronymi Mez	S	He		X	inter (2)		X	extended (12)	ZOO	36880
Tillandsia didisticha (E.Morren) Baker	E	He	X		inter (4)	ind.	ind.	ind.	ANEMO	36893
Tillandsia duratii Vis.	E	He		X	ind.	ind.	ind.	ind.	ANEMO	36881
Tillandsia loliacea Mart. ex Schult. f.	E	He		X	ind.	ind.	ind.	ind.	ANEMO	36882
Tillandsia recurvifolia Hook.	E	He		X	ind.	ind.	ind.	ind.	ANEMO	36883
Cactaceae										
Cereus bicolor Rizzini e Mattos	A	Ph		X	inter (3)		X	inter (3)	ZOO	
Cleistocactus cf. *baumannii* (Lem.) Lem.	S	He		X	inter (2)		X	brief (1)	ZOO	35477
Echnopsis rhodotricha K. Schum.	S	Ch		X	inter (2)		X	brief (1)	ZOO	36887
Harrisia balansae (K. Schum.) N.P. Taylor and Zappi	S	Ph	X	X	inter (6)		X	inter (4)	ZOO	35455
Opuntia bergeriana F.A.C. Weber	S	He		X	inter (2)		X	brief (1)	ZOO	35475

Table 1. ***Continued.***

SPECIES	Habit	Life form	FLOWERING			FRUTIFICATION				CGMS
			Season		Duration	Season		Duration	Dispersal	record
			Dry	Wet	(n° months)	Dry	Wet	(n° months)	syndrome	n°
Pereskia sacharosa Griseb.	S	Ph		X	inter (4)		X	inter (5)	ZOO	35454
Rhipsalis cf. *baccifera* (J.S. Muell.) Stearn	E	Te	X	X	inter (3)	X	X	extended (9)	ZOO	36886
Capparaceae										
Capparis retusa Griseb.	A	Ph		X	inter (2)		X	inter (2)	ZOO	35453
Cleomaceae										
Cleome guianensis Aubl.	H	Te	X	X	inter (4)		X	brief (1)	AUTO	35426
Commelinaceae										
Commelina nudiflora L.	H	He		X	brief (1)	X		brief (1)	AUTO	35262
Tradescantia sp.	H	He		X	inter (2)	ind.	ind.	ind.	AUTO	35483
Tripogandra glandulosa (Seub.) Rohw.	H	He		X	inter (4)		X	inter (6)	AUTO	35478
Convolvulaceae										
Evolvulus sericeus Sw.	H	Te	X	X	inter (2)			extended (6)	AUTO	35442
Ipomoea sp.	L	Te	X		brief (1)	ind.	ind.	ind.	AUTO	35470
Euphorbiaceae										
Cnidoscolus urens (L.) Arthur	S	Ch	X		inter (4)	ind.	ind.	ind.	AUTO	35476
Croton sp. 1	S	Ch		X	inter (2)	ind.	ind.	ind.	AUTO	35441
Croton sp. 2	S	Ch		X	brief (1)	ind.	ind.	ind.	AUTO	35443
Euphorbia hyssopifolia L.	H	Te	X	X	brief (1)	X	X	extended (7)	AUTO	37101
Jatropha sp.	S	He	X	X	extended (12)	ind.	ind.	ind.	AUTO	35479
Lamiaceae										
Hyptis brevipes Poit.	H	Te	X		brief (1)	X		brief (1)	AUTO	37107
Leguminosae										
Aeschynomene mollicula Kunth.	H	He		X	brief (1)	ind.	ind.	ind.	AUTO	35430
Arachis microsperma Krapov., W.C. Greg. and Valls	H	He	X	X	inter (3)	X	X	brief (1)	AUTO	35434
Chamaecrista serpens (L.) Greene	H	He	X	X	inter (2)	ind.	ind.	ind.	AUTO	35422
Galactia latisiliqua Desv.	H	He	X	X	inter (3)		X	brief (1)	AUTO	35427
Galactia paraguariensis Chodat and Hassl.	S	Te		X	inter (4)	X	X	extended (7)	AUTO	35428
Mimosa sensibilis Benth.	A	He	X	X	extended (4)	ind.	ind.	ind.	AUTO	35464
Mimosa sp.	S	He	X		brief (1)	ind.	ind.	ind.	AUTO	35433
Neptunia pubescens Benth.	S	Ge		X	inter (2)	ind.	ind.	ind.	AUTO	35466
Parkinsonia praecox (Ruiz and Pav. ex. Hook.) Hawkins	A	Ph	X		inter (2)	ind.	ind.	ind.	AUTO	35472
Prosopis rubriflora Hassl.	A	Ph	X	X	extended (12)	ind.	ind.	ind.	AUTO	35469
Senegalia sp.	A	Ph	X		brief (1)	ind.	ind.	ind.	AUTO	35467
Senna pilifera (Vog.) H.S. Irwin and Barneby	H	He	X		inter (3)		X	brief (1)	AUTO	35465
Stylosanthes hamata (L.) Taub.	H	He	X	X	extended (6)	X	X	brief (1)	AUTO	35458
Zornia reticulata Sm.	H	He		X	brief (1)		X	brief (1)	AUTO	35432
Lythraceae										
Cuphea thymoides Cham. and Schltdl.	H	Ch		X	inter (3)	ind.	ind.	ind.	AUTO	35438
Malpighiaceae										
Heteropterys glabra Hook. and Arn.	L	Te	X		brief (1)	X		brief (1)	ANEMO	35460
Malpighiaceae 1	L	Te	X	X	brief (1)	ind.	ind.	ind.	ANEMO	35481
Malvaceae										
Ayenia tomentosa L.	H	Ch	X		brief (1)	X		brief (1)	AUTO	35461
Corchorus argutus Kunth.	H	He	X		brief (1)	X		brief (1)	AUTO	36890
Herissantia nemoralis (A.St. Hil.) Briz.	H	Ch		X	brief (1)	ind.	ind.	ind.	AUTO	35420
Melochia pyramidata L.	H	He		X	inter (2)	ind.	ind.	ind.	AUTO	35448
Pavonia sidifolia Kunth	A	Ch	X	X	extended (7)		X	inter (4)	AUTO	35456
Sida angustissima A. St-Hilaire	H	Ch		X	brief (1)		X	breve (1)	AUTO	35273
Sida cerradoensis Krap.	S	Ch	X	X	inter (4)	X		inter (2)	AUTO	35425
Sida rhombifolia L.				X	brief (1)	ind.	ind.	ind.	AUTO	35468
Waltheria indica L.	S	Ch	X	X	inter (3)	X	X	brief (1)	AUTO	35423
Molluginaceae										
Mollugo verticillata L.	H	Te	X	X	extended (7)	X	X	extended (8)	ZOO	35421
Myrtaceae										
Myrtaceae 1	A	Ph	X		brief (1)	und.	und.	und.	ZOO	35471
Onagraceae										
Ludwigia lagunae (Morong) H. Hara	H	Te	X		brief (1)	X		brief (1)	ANEMO	37105

Table 1. ***Continued.***

SPECIES	Habit	Life form	FLOWERING			FRUTIFICATION				CGMS
			Season		Duration	Season		Duration	Dispersal	record
			Dry	Wet	(n° months)	Dry	Wet	(n° months)	syndrome	n°
Oxalidaceae										
Oxalis latifolia Kunth.	H	Ge	X		inter (4)	X		inter (3)	AUTO	35269
Oxalis physocalyx Zucc. ex Progel	H	Te	X		brief (1)	X		inter (3)	AUTO	37108
Plantaginaceae										
Monopera sp.	H	Te		X	brief (1)		X	brief (1)	AUTO	35439
Scoparia montevidensis (Spreng.) R.E. Fr.	H	Te	X	X	extended (8)	X		extended (10)	AUTO	35418
Portulacaceae										
Portulaca fluvialis D. Legrand	H	Ge	X	X	extended (7)		X	inter (4)	AUTO	35451
Portulaca striata Poelln.	H	Ge	X	X	inter (5)	X	X	inter (4)	AUTO	35435
Rubiaceae										
Spermacoce eryngioides Cham. and Schltdl.	H	Ch	X	X	extended (10)	X	X	extended (8)	AUTO	35457
Staelia thymoides Cham. and Schltdl.	H	Te	X		inter (2)	X		brief (1)	AUTO	35429
Rhamnaceae										
Ziziphus mistol Griseb.	A	Ph	X	X	inter (5)	X	X	extended (8)	ZOO	35463
Simaroubaceae										
Castela coccinea Griseb.	A	Ph	X		inter (3)	X		inter (4)	ZOO	35480
Talinaceae										
Talinum triangulare (Jacq.) Willd	H	Ge	X		brief (1)	X		brief(1)	AUTO	35459
Verbenaceae										
Lippia alba (Mill.) Br. ex Britt.and Wilson	S	Ch	X		brief (1)	X		brief (1)	AUTO	37109
Stachytarpheta elatior Schr. ex Schult	S	Ch	X		brief (1)	X		inter (3)	AUTO	35474

Acknowledgments: We are grateful to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the financial support; Sérgio de Oliveira for the permission to work on his ranch "Retiro Conceição"; Fábia Silva de Carvalho and Bárbara Ellen de Medeiros Pinto for the species identification; and Mariana Ferrari Felismino for the English revision.

Literature Cited

Alves, F.M. and A.L.B. Sartori. 2009. Caesalpinioideae (Leguminosae) de um remanescente de Chaco em Porto Murtinho, Mato Grosso Do Sul, Brasil. *Rodriguésia* 60(3): 531-550.

Augspurger, C.K. and S.E. Franson. 1987. Wind dispersal of artificial fruits varying in mass, area and morphology. *Ecology* 68(1): 27-42.

APG III. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society* 161(2): 105–121.

Ashworth, L. and L. Galetto. 2001. Pollinators and Reproductive Success of the Wild Cucurbit *Cucurbita maxima* ssp. Andreana (Cucurbitaceae). *Plant biology* 3(4): 398-404.

Batalha, M.A., S. Aragaki and W. Mantovani. 1997. Florística do cerrado em Emas (Pirassununga, SP). *Boletim de Botânica da Universidade de São Paulo* 16: 49-64.

Batalha, M.A. and W. Mantovani. 2000. Reproductive phenological patterns of cerrado plant species at the Pé-de-Gigante Reserve (Santa Rita do Passa Quatro, SP, Brazil): a comparasion between and wood floras. *Revista Brasileira de Biologia* 60(1): 129-145.

Batalha, M.A. and F.R. Martins. 2004. Reproductive phenology of the cerrado community in Emas National Park (central Brazil). *Australian Journal of Botany* 52(2): 149-161.

Bianchi, M.B. and P.E. Gibbs. 2000. Late-acting self-incompatibility in *Capparis retusa* (Capparaceae), a species of Chaco woodland in NE Argentina. *Revista Brasileira de Botânica* 23(4): 395-400.

Cagnolo, L., M. Cabido and G. Valladares. 2006. Plant species richness in the Chaco Serrano Woodland from central Argentina: Ecological traits and habitat fragmentation effects. *Biological Conservation* 132(4): 510-519.

Castillo, S. and J. Cambias. 1982. Ecologia de la vegetación de dunas costeras: fenologia. *Biotica* 7(4): 551-567.

Dubs, B. 1998. Leguminosae – Caesalpinioideae; p. 140-148 *In* B. Dubs (ed.). *Prodromus florae matogrossensis*. Kusnacht: Betrona-Verlag. 444 p.

Dutra, V. F., M. F. Vieira, F. C. P. Garcia and H. C. Lima. 2009. Fenologia reprodutiva, síndromes de polinização e dispersão em espécies de Leguminosae dos Campos Rupestres do Parque Estadual do Itacolomi, Minas Gerais, Brasil. *Rodriguésia* 60(2): 371–387.

Felfili, J.M., M.C. Silva-Júnior, B.J. Dias and A.V. Rezende. 1999. Estudo fenológico de *Stryphnodendron adstringens* (Mart.) Coville no cerrado *sensu stricto* da Fazenda Água Limpa no Distrito Federal, Brasil. *Revista Brasileira de Botânica* 22(1): 83-90.

Franco, A.C. 2002. Ecophysiology of woody plants: p. 178-197 *In* P.S. Oliveira and R.J. Marquis (ed.). *The cerrados of Brazil: ecology and natural history of a neotropical savanna.* Irvington:, Columbia University Press. 398 p,

Guedes-Bruni, R.R., M.P.M. Morin, H.C. Lima and L.S. Sylvestre. 2002. Inventário florístico; p. 24-49 *In* L.S Sylvestre and M.M.T. Rosa (org.): *Manual metodológico para estudos botânicos na Mata Atlântica*. Rio de Janeiro: Ed. Seropédica. 121 p.

Mantovani, W. and F.R. Martins. 1988. Variações fenológicas das espécies do Cerrado da Reserva Biológica de Mogi Guaçu, Estado de São Paulo. *Revista Brasileira de Botânica* 11(2): 101-112.

Marco, D.E. and S.A. Páez. 2002. Phenology and phylogeny of animal-dispersed plants in a Dry Chaco forest (Argentina). *Journal of Arid Environments* 52(1): 1-16.

Marino, G.D. and J.F. Pensiero. 2003. Heterogeneidad florística y estructural de los bosques de *Schinopsis balansae* (Anacardiaceae) em el sur del Chaco húmedo. *Darwiniana* 41(1-4): 17-28.

Monasterio, M. and G. Sarmiento. 1976. Phenological strategies em species of seasonal savana and semideciduous forest in the Venezuelan Llanos. *Journal of Biogeography* 3(4): 325-355.

Morellato, L.P.C. and H.F. Leitão-Filho. 1996. Reproductive phenology of climbers in a Southeasthern Brazilian forest. *Biotropica* 28(2): 180-191.

Munhoz, C.B.R. and J.M. Felfili. 2005. Fenologia do estrato herbáceo-subarbustivo de uma comunidade de campo sujo na Fazenda Água Limpa no Distrito Federal, Brasil. *Acta Botânica Brasílica* 19(4): 979-988.

Munhoz, C.B.R. and J.M. Felfili. 2007. Reproductive phenology of an herbaceous-subshrub layer of a Savannah (Campo Sujo) in the Cerrado Biosphere Reserve I, Brazil. *Brazil Journal of Biology*, 67(2): 299-307.

Newstrom, L.E., G.M. Frankie and H.G. Baker. 1994. A new classification for plant phenology based on flowering patterns in lowland tropical rain forest trees at La Selva. *Biotropica* 26(2): 141-159.

Noguchi, D.K., G.P. Nunes and A.L.B. Sartori. 2009. Florística e síndromes de dispersão de espécies arbóreas em remanescentes de chaco de Porto Murtinho, Mato Grosso do Sul, Brasil. *Rodriguésia* 60(2): 353-365.

Nunes, G.P. 2006. *Estudo florístico de formações chaquenhas brasileiras e caracterização estrutural de um remanescente de Chaco de Porto Murtinho, MS, Brasil.* Dissertação (Mestrado em Ecologia e Conservação). Campo Grande: Universidade Federal de Mato Grosso do Sul. 76 p.

Ogle, D. and J.F. Reynolds. 2004. Reviewed plant responses to precipitation in desert ecosystems: integrating functional types, pulses,thresholds.

Oecologia 141(2): 282-294.
Oliveira, P.E.A.M. and A.G. Moreira. 1992. Anemocoria em espécies de cerrado e mata de galeria de Brasília, DF. *Revista Brasileira de Botânica* 15(2): 163-174.
Oliveira, P.E. 1998. Fenologia e biologia reprodutiva de espécies de cerrado; p. 169-192 *In* S.M. Sano and S.P. de Almeida (ed.). *Cerrado: ambiente e flora*. Planaltina: Embrapa-CPAC, 556 p.
Pennington, R.T., D.E. Prado and C.A. Pendry. 2000. Neotropical seasonally dry forests and quarternary vegetation changes. *Journal of Biogeography* 27(2): 261-273.
Pijl, van der.L. 1982. *Principles of dispersal in higher plants.* Berlin: Springer-Verlag. 402 p.
Prado, D.E. 1993. What is the Gran Chaco vegetation in South America? A redefinition. Contribution to the study of flora and vegetation of the Chaco. VII. *Candollea* 48(2): 615-629.
Radford, A. E., W.C. Dickinson, J.R. Massey and C.R. Bell. 1974. *Vascular plant systematics.* New York: Harper & Row Publishers. 891 p.
Rebellato, L. and C.N. Cunha. 2005. Efeito do fluxo sazonal mínimo da inundação sobre a composição e estrutura de um campo inundável no Pantanal de Poconé, MT, Brasil. *Acta Botânica Brasilica* 14(4): 789-799.
Silva, J.S.V. and M.M. Abdon. 1998. Delimitação do Pantanal Brasileiro e suas sub-regiões. *Pesquisa Agropecuaria Brasileira* 33(nesp): 1703-1711.
Silva, M.P., R. Mauro, G. Mourão and M. Coutinho. 2000. Distribuição e quantificação de classes de vegetação do Pantanal através de levantamento aéreo. *Revista Brasileira de Botânica* 23(2): 143-152.
Souza, F.L., M. Uetanabaro, P. Landgref-Filho, L. Piatti, and C.P.A. Prado. 2010. Herpetofauna, municipality of Porto Murtinho, Chaco region, state of Mato Grosso do Sul, Brazil. *Check List* 6(3): 470-475.
Tannus, J.L.S., M.A. Assis and L.P. Morellato. 2006. Fenologia reprodutiva em campo sujo e campo úmido numa área de Cerrado no sudeste do Brasil, Itirapina - SP. *Biota Neotropica* 6(3): 1-27.
Torres, C. and L. Galetto. 2011. Flowering phenology of co-occurring Asteraceae: a matter of climate, ecological interactions, plant attributes or of evolutionary relationships among species? *Organisms Diversity & Evolution* 11(1): 9–19.
Vieira, D.L.M., F.G. Aquino, M.A. Brito, C. Fernandes-Bulhão and R.P.B. Henriques. 2002. Síndromes de dispersão de espécies arbustivo-arbóreas em cerrado *sensu stricto* do Brasil Central e savanas amazônicas. *Revista Brasileira de Botânica* 25(2): 215-220.
Walter, H. 1986. *Vegetação e zonas climáticas: tratado de ecologia global*. São Paulo: EPU. 325 p.
Zak, M. R. and M. Cabido. 2002. Spatial patterns of the Chaco vegetation of central Argentina: Integration of remote sensing and phytosociology. *Applied Vegetation Science* 5(2): 213-226.

Received: March 2013
Accepted: September 2013
Published online: October 2013
Editorial responsibility: Pedro V. Eisenlohr