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+The phenology of species in a swamp forest in Bauru, SP

+ A fenologia das espécies em uma floresta pântica em Bauru, SP

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ABSTRACT
The way both phenophase and periodicity occur is crucial to define phenological patterns of species and communities. These studies are of great importance in order to understand the behavior of such communities in relation to climate variability, the measurement of the amount of fruit and the best time for seed collection. Thus, this work has the objective to describe the phenological patterns of the twelve most important species within their phytosociological structure from an arboreal shrub community in a swamp forest in the municipality of Bauru, SP. We have noticed that most of the species, the anthesis, occurred in the beginning and in the end of the dry season. For fruiting phenophase, the pattern has presented a greater variation from one year to another, meaning that in the first year, 75% of the individuals bore fruit during the dry season. On the other hand, lower fructification has been noticed throughout the same period (June to October) of the following year. Thus, we could get to the conclusion that anthesis phenophase has a strong correlation with the changing seasons. Fruiting phenophases have not shown to have a clear pattern. We could notice that fructification is strongly related with precipitation variability index, and it can be explained since there was a significant increase of rainfall and a decrease of fructification in the second year.

Keywords: phenology, anthesis, fructification, swamp forest, rainfall.

RESUMO
A forma como a fenofase e a periodicidade ocorrem é crucial para definir os padrões fenológicos de espécies e comunidades. Esses estudos são de grande importância para o entendimento do comportamento dessas comunidades em relação à variabilidade climática, a mensuração da quantidade de frutos e a melhor época para a coleta de sementes. Assim, este trabalho tem o objetivo de descrever os padrões fenológicos das doze espécies mais importantes dentro de sua estrutura fitossociológica de uma comunidade arbustiva arbórea de uma floresta pantanosa no município de Bauru, SP. Notamos que a maioria das espécies, a antese, ocorreu no início e no final da estação seca. Para a fenofase de frutificação, o padrão apresentou maior variação de um ano para o outro, ou seja,

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no primeiro ano, 75% dos indivíduos frutificaram na estação seca. Por outro lado, menor frutificação foi observada ao longo do mesmo período (junho a outubro) do ano seguinte. Assim, podemos chegar à conclusão de que a fenofase da antese tem forte correlação com as mudanças das estações. As fenofases de frutificação não demonstraram ter um padrão claro. Pudemos notar que a frutificação está fortemente relacionada com o índice de variabilidade da precipitação, o que pode ser explicado uma vez que houve um aumento significativo da precipitação e uma diminuição da frutificação no segundo ano.

Palavras-chave: fenologia, antese, frutificação, floresta pantanosa, precipitação.

1 INTRODUCTION

A swamp forest is a forestal formation featured by the presence of water on the soil surface almost permanently throughout the year due to water table in lowlands, relief depressions, and banks of watercourses (Teixeira & Assis 2009). Changes of both floristic pattern and structural vegetation in flooding areas occur due to environmental heterogeneity associated with flooding features, i.e., different levels of soil oxygenation and sedimentation patterns (Silva *et al*. 2007).

Swamp forests are predominantly located on hydromorphic soils, where bold fragmentation process might have occurred due to deforestation that could have happened in recent years, the use of agricultural floodplains programs, fire and the construction of hydroelectric power plants, those which ended up causing a large impact on this formation (Ivanauskas *et al.* 1997; Kurtz *et al.* 2013). According to Kunt and collaborators (2015), swamp forests are gradually heading towards extinction, even if its ecological features and importance when it comes to the protection of water supply courses are still unknown. Much relevant information on ecology related to this formation has not been quite explored. We can take as an example to prove that, the subject about the existence of succession process or the clearing dynamics in those forests, and so many other subjects show our limited capacity of preservation or restoration of such peculiar ecosystem.

The studies regarding the phenology of riparian and swamp forests contribute to the comprehension of diversity, dynamics and species distribution of the plant communities (Chuine & Beaubien 2001) benefiting the comprehension of the mechanisms of both reproduction and species regeneration (Talora & Morellato 2000; Mantovani *et al.* 2003). This way, the study related to the rhythm of repetitive biological events, their causes in relation to the environment, the possible interrelations of phenophases, their resources and competitors, within many species allow the assessment of potential availability of resources in the fauna throughout the year (Scudeller *et al.* 2009).

The phenological studies can be applied to indicate the right season for seed collection, enrichment and restoration of degraded areas, since they provide a harvest calendar based on fruiting phenophase (Mantovani *et al.* 2003, Machado *et al.* 2013).

Recent studies, of swamp forests in Brazil, have been focused on descriptive analysis of the floristic composition and structural communities, the distribution patterns of the species of different regions, and the influence of the vegetation close to riparian areas on themselves (Kurtz *et al.* 2014; Kurtz *et al.* 2013; Kurtz *et al.* 2015). Unfortunately, there have been published few studies about phenology and the comprehension of forestal restoration processes in swamp forests. Researches in such area would be of great help and they would bring to light the dynamics of forestal communities, and they would also suggest possible relations among environmental factors and the biological responses of individuals of the community (Spina *et al.* 2001).

Thus, this work has the objective to describe the phenological patterns of the twelve most important species within their phytosociological structure from an arboreal shrub community in a swamp forest.

2 MATERIALS AND METHODS

2.1 STUDY AREA

The study has been made in a fragmented swamp forest located on *campus* at "Universidade Estadual Paulista Júlio de Mesquita Filho" (UNESP) (FPUBA). The swamp forest of about 2.3 ha is located on a *campus* legal reserve which has 132 ha, under the following coordinates 22º 20'S and 49º 01'W, and altitude of 1837.27 feet.

The analyzed swamp forest has hydromorphic soils - Gley Soil type, acid and high concentration of organic matter (Carboni 2007).

The climate in the municipality of Bauru can be defined according to the Köppen classification as Cfa type - humid subtropical climate, and hot summer seasons (Alvares *et al.* 2013). The annual average precipitation goes around 1.389ml, and the annual average temperature was of 69,62°F (Alvares *et al.* 2013). The average temperature and precipitation during summer (December, January and February) were respectively 453.2°F and 216ml, and during winter (May, June, July) 352.4°F and 50ml, based on Köppen's climate classification map for Brazil (Alvares *et al.* 2013).

2.2 SPECIES SELECTION

Twelve species of trees and shurbs have been selected being them the most abundant in the forest and they have presented the highest prominent value index (Carboni 2007). The species were: *Ardisia ambigua* Mart.; *Myrsine gardneriana* DC.; *Calophyllum brasiliense* Cambess.; *Cedrela*

odorata L.; *Guarea kunthiana* A. Juss.; *Dendropanax cuneatus* (DC.) Decne. & Planch.; *Geonoma brevispatha* Barb. Rodr.; *Magnolia ovata* (A. St.-Hil.) Spreng.; *Protium spruceanum* (Benth.) Engl.; *Styrax pohlii* A. DC.; *Tapirira guianensis* Aubl. and *Xylopia emarginata* Mart. Among these species, we should point out the importance of data creation of *Calophyllum brasiliensis*, *Tapirira guianensis*, *Pera glabrata*, and *Alchornea triplinervia* since these species have been considered the ones of major frequency in the study made by Kurtz and collaborators (2014), related to floristic survey made in thirty-seven swamp forests in both south and southeast regions of Brazil.

2.3 REPRODUCTIVE PHENOLOGY

A monthly follow up was made about the flowering and fruiting phenophases of the twelve species of shurb-trees selected, and a total of 99 individuals were marked from June 2009 to December 2010. The selected individuals were those which presented larger sizes (so that we could be reassured they were in the adult phase), whose canopy would allow the visualization of fruit quantification. We could notice an average of 8.25 individuals per specie, i.e., a higher number out of five required by Fournier & Charpantier (1975), for the phenology study of tropical plants and monthly harvests.

The characterization of potential pattern of propagules dispersal from the analyzed species has been made taking into consideration three dispersal syndromes: anemochoric species, zoochoric, and autochoric species.

Estimates of the average number of seeds per fruit and the total of fruits per individual have been made with the purpose of a further estimate of seed production of the same population, and such a method was based on Fournier (1974).

The reproductive phenophases of the studied species have been compared to the data precipitation and temperature collected throughout the years of study at *Estação Meteorológica do IPMEt- Instituto de Pesquisas Meteorológicas de Bauru* (2010).

3 RESULTS

The data analysis of the twelve species were collected during the periods when the two highest peaks of flowering happened - one in the first year from October to November, and from March to May. The second highest peak of flowering occurred in the second year at the end of the dry season - from August to October. There was a significant difference concerning the extra specific timing from one year to another, which peaks of a higher synchronization of individuals were presented in the second year. The peak flowering at the beginning of the dry season, March to May, was mainly determined by the following species: *Geonoma brevispatha*, *Myrsine gardneriana* and *Dendropanax*

cuneatus. On the other hand, the second and biggest peak of flowering was determined by the flowering of the following species: *Protium spruceanum*, *Calophyllum brasiliense*, *Tapirira guianensis* and *Cedrela odorata* (Figs. 1, 2 A and B). This way, we can infer that for most of the species the anthesis phenophase occurred either in April or in September/October. This phenophase took place mainly at the beginning and at the end of the dry season (Fig. 1).

From 99% of the analyzed individuals, 89% blossomed throughout this study being *Ardisia ambigua*, a typical understory specie, which presented the lowest number of individuals in the process of flowering phenophase for nineteen months. This had happened right in the beginning of the study, in 2009, when this specie had already grown fruits, only one out of eight, and it blossomed again in April 2010.

The analyzed studies were divided into: supra-annual for *A.ambigua, G.kunthiana, T.guianensis, D. cuneatus, S.pholli,* having flowering cycle gaps higher than one year, and annually for *M. gardneriana, C.odorata, M.ovata*whose flowering cycle took place only once a year. For the species, *P.spruceanum* and *C.brasiliense* flowering was sub-annual, having more than one flowering cycle in a year divided into two seasons. The species *G. brevispatha* and *X. emarginata* blossomed throughout the whole year, and despite they presented some short periods of interruption concerning their production of flowers and flower buds, and according to Newstrom and collaborators (1994) had their flowering frequency categorized as continuous (Fig.2A-B).

Cedrela odorata species, *Tapirira guianensis*, and *Myrsine gardneriana* have presented great synchronicity of anthesis phenophase, meaning that 75% to 100% of its individuals flowered at the same time. *Calophyllum brasiliensis* and *Xylopia emarginata* species were the species which presented lower phenophase synchronicity, i.e., that few individuals blossomed at the same time taking a long time to do so.

We can notice that there is not a general synchronicity between the species in relation to the flowering period just like some species which have presented an intra specific timing. However, it is possible to notice that at least one specie presented anthesis in most part of the analyzed year (Fig.3).

On Table 1, the following items can be seen: twelve analyzed species, flowering and fruiting periods, estimates of the number produced seeds when the study took place, and the dispersal syndrome.

Zoochoric, was the dispersal syndrome, presented in most of the species, and only *Cedrela odorata* L. presented anemochoric syndrome among the analyzed species.

The species with larger production of seeds were the following: *M. gardneriana*, *M. ovata* and *X. emarginata*, zoochoric species. The three species presented continuous fruiting during the year and the *M. gardneriana* presented greater seed production in the period (Tab. 1).

For fruiting phenophase, 75% of the studied population bore fruit during the dry season, from June to October (Fig. 4). The highest fructification peak occurred in the dry season in the first year of assessment - 2009. However, it does not seem to be a pattern that repeats every year, and it may vary according to the precipitation index, since there was no fructification peak from June to October 2010. This phenomenon might be related with rainfall increase due to water surplus that occurred from September to December 2009 and which doubled the volume during the same period of time, ten years ago.

Ardisia ambígua, *Dendropanax cuneatus*, and *Guarea kunthiana* species bore fruit only in the dry season, although only the first ones presented 50 to 60 % of intra specific timing. *G. kunthiana* presented a lower timing among other individuals in such phenophase (Fig. 5). *Calophyllum brasiliensis* bore fruit year after year during the dry season and in another year, it bore fruit between the end of the dry season and the beginning of the humid one. *Cedrela odorata* bore fruit only during the most humid period and in the lowest intra specific timing. *Geonoma brevispatha* species presented continuous fructification throughout the second year with low intra specific timing. *Magnolia ovata*, *Protium spruceanum*, *Myrsine gardneriana*, and *Xylopia emarginata* also presented continuous fructification with high intra specific timing. Finally, *Stirax pohlii* and *Tapirira guianensis* only bore fruit at the beginning of the rainy season and the maximum intra specific timing was out of 50% of the individuals.

Species such as *A.ambigua*, *M.ovata*, *P.spruceanum*, *M.garderiana*, *X.emarginata* were the ones, which presented greater intra specific timing ranging from 60% to 100% of individuals bearing fruit in the same season (Fig.5). On the other hand, *G.brevispatha* was the only specie that presented lower timing among the individuals, bearing fruit, generally most part of the year.

We can see in figure number 6 that the fructification in general occurred all over the year presenting a slight increase on the number of species during the dry season (June to October), and there was not an evident specific extra timing. The seasons, when there was a reduction of the number of fruiting species, ranged from November 2009 to January 2010 (19 months), and later in September 2010.

4 DISCUSSION

Seasons in general are less bold in rainforests and present a range of pollinators and dispersers all over the year making the species present reproductive phenology with a less bold seasonality, leading to a pattern in which flowering and fruiting can be manifested many times along the year or continuously (Marques & Oliveira 2004; Bollen & Donati 2005). This way, in this study, the flowering and fruiting seasons did not present a short period of time or only occurred during a specific

period of the year concerning the reproductive phenophases, not having a clear pattern, ranging from year to year and all that happened in accordance with the literature.

The work done by Spina et al (2001), concerning his phenological study in the swamp forest community in the municipality of Campinas, has highlighted that most of the species bore fruit between the months of August and October, confirming the results from this study, which most of the species presented phenophases in the same season (August to October). In the rainforests, the period of occurrence of anthesis phenophase has been associated with abiotic factors such as: temperature, precipitation, air and soil humidity (Marques *et al.* 2004; Marchioretto *et al.* 2007; Gunter *et al.* 2008; Liebsch & Bos Mikich 2009; Lima *et al.* 2018). Morellato and collaborators (1989) and Marques & Oliveira (2004) have suggested in their studies that flowering could be led by the increase of photoperiod, temperature and humidity, during the changing seasons, as it is the case of this study and Spina's (2001), and that occurred mainly during the transition from winter to spring. However, the change in the photoperiod may be presented as a relevant leading factor of the phenophase in rainforests (Marques *et al.* 2004; Borchet *et al.* 2005; Stevenson *et al.* 2008).

According to Gressler (2010), in an Ombrophilous Dense Forest, she got to the conclusion that precipitation was the second factor which presented the biggest correlation with a phenology community in the municipality of Picinguaba, SP. The same result was observed in study of phenology plants in Caatinga (Santos *et al.* 2020).

Concerning this study, the months between September to December 2009 corresponded to the period which presented higher water surplus (Fig. 1), reaching two times more the amount of rainfall recorded in similar period of time, however, ten years ago. It has clearly showed a negative correlation of anthesis phenophase, and consequently, it has affected fruiting production and confirmed that precipitation directly influences and plays an important role on reproductive phenophase.

In relation to the dispersal syndrome, we could notice that 91,6% of the species were zoochoric and they were in full compliance with what has been mentioned by Spina et al (2001). Zoochoric got 75% of species, and Locatelli & Machado (2004) has found out that in upper swamp forests zoochoric species are represented by the total of 66%.

For fruiting phenophase, Spina et al (2001) suggested according to their given outcome, that there were species bearing fruit all over the year in the community, and the highest fructification peaks took place in June (41%) and in August (30%). In this field of study, one could see that the months of August and September were periods with the highest fructification peaks, although there were great quantity of fruiting species in the months of June and July. Marchioretto *et al.* (2007) have studied the phenology of zoochoric tree species in a sandy coastal forest, where they could analyze the fruiting production all over the year, but with minor correlations between this event and the

environment variables observed by Marques *et al.* (2004) in an area of Dense Ombrophylous Forest, which presents systematic dry season.

Rubim *et al.* (2010), in the process of analyzing a semideciduous stationery forest in the state of São Paulo, has verified that flowering and fruiting patterns were not significantly seasonal during the four-year study. In addition to that, two phenophases did not present similar flowering and fruiting patterns in the consecutive years. It showed that the intensity of the two phenophases could be related to the inter-annual variability precipitation and temperature, or even to be related to the species ecology such as the availability of reserves, etc. This result complies with the ones presented in this study, since the phenology of the twelve populations in the swamp forest in the municipality of Bauru throughout 19 months, has pointed out to the seasonality of the reproductive phenophases ranging from year to year.

The swamp forests are basically composed of three distinct groups of species: the specialist species in constantly flooded areas; the generalist species (unaffected by water table variations); and the ones which prefer drained soils (Ivanauskas *et al.* 1997, Kurtz *et al.* 2013, Kurtz *et al.* 2015). This way, the water table variation may affect deeply the composition, diversity and structure of the swamp forests being them of extreme importance to the successional process (Kurtz *et al.* 2015), as for the reproductive phenophases as well.

We got to the conclusion then that the precipitation variation played a vital role in the reproductive phenophases as whole in the community, ranging from year to year in relation to the extra specific timing and in some species in the intraspecific variation. In general, the reproductive phenophases were more present in the driest period of the year, mainly in the months of changing seasons (April and September). Species such as *M. gardneriana*, *M. ovata* and *X. emarginata* (all zoochoric) seemed to have fundamental importance on the local fauna, since they presented great amount of fruits and continuous fructification so that they did not seem to suffer from variations in fruiting and flowering production, and they did not present direct correlation with possible changes concerning precipitation rate. Thus, they are considered as interesting species for seed collection, fruiting production and usage in degraded swamp forest restoration.

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REFERENCES

Alvares CA, Stape JL, Sentelhas PC, Gonçalves JLM, Sparovek G. 2013. Climate classification map for Brazil. Meteorologische Zeitschrift, 22, 711–728. (in press): doi.org/10.1127/0941-2948/2013/0507.

Attanasio CM, Gandolfi S, Zakia MJB, Veneziani Junior JCT, Lima WP. 2012. A importância das áreas ripárias para a sustentabilidade hidrológica do uso da terra em microbacias hidrográficas. Bragantia, Campinas, 71: 493-501.

Bollen A, Donati G. 2005. Phenology of the Littoral Forest of Sainte Luce, Southeastern Madagascar. Biotropica, 37:32-43. doi: 10.1111/j.1744-7429.2005.04094.x.

Borchert R, Renner SS, Calle Z, *et al*. 2005. Photoperiodic induction of synchronous flowering near the Equator. Nature, 10;433(7026):627-9 (in press). doi:10.1038/nature03259.

Carboni M. 2007. Composição, estrutura e diversidade vegetal de uma floresta estacional semidecídua ribeirinha com influência fluvial permanente (mata de brejo) em Bauru – SP. MSc Thesis. Universidade Estadual Paulista "Júlio de Mesquita Filho", Botucatu.

Chuine I, Beaubien, EG. 2001. Phenology is a major determinant of tree species range. Ecology Letters,4:500-510.

Fournier LA.1974. Un método cuantitativo para la medición de características fenológicas en árboles. Turrialba, San Juan, 24:422-423.

Fournier LA, Charpantier C. 1975. El tamaño de la muestra y la frecuencia de las observaciones en el estudio de las características fenológicas de los árboles tropicales. Turrialba, San Juan, 25:45-48.

Gressler E. 2010. Fenologia de espécies de Floresta Atlântica, Núcleo Picinguaba,Parque Estadual da Serra do Mar, Estado de São Paulo: comparação entre estratos e influência de borda natural. PHd Thesis, Universidade Estadual Paulista "Júlio de Mesquita Filho", Rio Claro.

Gunter S, Stimm B, Cabrera M et al. 2008. Tree phenology in montane forests of southern Ecuador can be explained by precipitation, radiation and photoperiodic control. Journal of Tropical Ecology. 24:247–258 (in press). doi: 10.1017/S0266467408005063

Ivanauskas NM, Rodrigues RR, Nave AG.1997. Aspectos ecológicos de um trecho de floresta de brejo em Itatinga, SP: florística, fitossociologia e seletividade de espécies. Revista Brasileira de Botânica, 20:139-153.

Kurtz BC, Gomes JC, Scarano FR. 2013. Structure and phytogeographic relationships of swamp forests of Southeast Brazil. Acta Botanica Brasilica 27(4): 647–660. (in press) doi.org/10.1590/S0102-33062013000400002.

Kurtz BC, Caris EAP, Scarano FR. 2014. Heterogeneity of the woody flora of swamp forests in southeastern and southern Brazil. Check List 10(6): 1359–1379. (in press) doi.org/10.15560/10.6.1359.

Kurtz BC, Valentin JL, Scarano FR. 2015. Are the neotropical swamp forests a distinguishable forest type? Patterns form southeast and southern Brazil. Edinburgh Journal of Botany 72 (2):191-208. (in press) doi.org/10.1017/S096042861400033X

Liebsch D, Bos Mikich S. 2009. Fenologia reprodutiva de espécies vegetais da Floresta Ombrófila Mista do Paraná, Brasil. Revista Brasileira de Botânica. 32 (2): 375-391. (in press) doi.org/10.1590/S0100-84042009000200016.

Lima WP, Zakia MJB. 2006. O papel do ecossistema ripário. In: Lima WP, Zakia MJB (eds.). As florestas plantadas e a água: Implementando o conceito da microbacia hidrográfica como unidade de planejamento. São Carlos: RiMa, p. 77-87.

Lima C R, Bruno R L A, Andreade A P, et al. 2018. Phenology of Poincianella pyramidalis (Tul.) L. P. Queiroz and its relationship with the temporal distribution of rainfall in the Brazilian semi-arid region. Ciência Florestal, Santa Maria, 28 (3): 1035-1048. doi.org/10.5902/1980509833387.

Locatelli EM, Machado IC. 2004. Fenologia de espécies arbóreas de uma Mata Serrana (Brejo de Altitude) em Pernambuco, Nordeste do Brasil. In: Porto KC, Cabral JJ, Tabarelli M. (eds.). Brejos de altitude em Pernambuco e Paraíba: história natural, ecologia e conservação. Brasília: Ministério do Meio ambiente, 1:255-276.

Machado MS, Brancalion PHS, Potascheff C, et al. 2013. Fenologia da frutificação de espécies vegetais nativas e a restauração florestal no arquipélago de Fernando de Noronha, PE, Brasil. Hoehnea, 40(3): 473-483.

Mantovani M, Ruschel AR, Reis MS, Puchalski A, Nodari, RO. 2003. Fenologia reprodutiva de espécies arbóreas de formações secundárias da Mata Atlântica. Revista Árvore, Viçosa, v. 27, n. 4, p. 451 - 458, 2003.

Marchioretto MS, Mauhs J, Budke JC. 2007. Fenologia de espécies arbóreas zoocóricas em uma floresta psamófila no sul do Brasil. *Acta Botânica Brasílica*, Porto Alegre, 21:193-201. Doi.org/10.1590/S0102-33062007000100018.

Marques MCM, Oliveira PEAM. 2004. Fenologia de espécies do dossel e do sub-bosque de duas florestas de restinga da Ilha do Mel, sul do Brasil. Revista Brasileira de Botânica, 27:713-723.

Marques MCM, Roper JJ, Salvalaggio APB. 2004. Phenological patterns among plant life forms in a subtropical forest in Southern Brazil. Plant Ecology, 173(2): 203-213. http://dx.doi.org/10.1023/B:VEGE.0000029325.85031.90.

Morellato LPC, Rodrigues RR, Leitão Filho HF, Joly CA. 1989. Estudo comparativo da fenologia de espécies arbóreas de floresta de altitude e floresta mesófila semidecídua na Serra do Japi, Jundiaí, São Paulo. Revista Brasileira de Botânica 12: 85-98.

Newstrom LE, Frankie GW, Baker HG.1994. A new classification for plant phenology based on flowering patterns in lowland tropical rain forest trees at La Selva, Costa Rica. Biotropica, Washington, 26:141-159.

Pinheiro MHO, Monteiro R, Cesar O. 2002. Levantamento fitossociológico da floresta estacional semidecidual do Jardim Botânico de Bauru, São Paulo. Naturalia, São Paulo, 27: 145-164.

Rubim P, Nascimento HEM, Morellato LPC. 2010. Variações interanuais na fenologia de uma comunidade arbórea de floresta semidecídua no sudeste do Brasil. Acta Botânica Brasílica, Porto Alegre, 24(3):756-764.

Santos EAV, Silva FL, Costa DB, Pereira FC. 2020. Desenvolvimento de métodos de recuperação de áreas degradadas no Seridó Paraibano aplicando novas técnicas de nucleação biológica com espécies de Cactaceae e Euphorbiaceae: Avaliação Preliminar. Brazilian Journal of Development, Curitiba, 6 (9), p.69302-69322.

Scudeller VV, Ramos RA, Cruz MEG. 2009. Flora fanerogâmica da floresta de terra firme na RDS Tupé. In: SANTOS-SILVA, E. N.; _____. (Orgs.). Diversidade Biológica e Sociocultural do Baixo Rio Negro, Amazônia Central. Manaus: UEA, p. 109-120.

Silva ACD, Van Den Berg E, Higuchi P, Oliveira ATDF. 2007. Comparação florística de florestas inundáveis das regiões Sudeste e Sul do Brasil. Revista Brasileira de Botânica, 30(2):257-269.

Spina AP, Ferreira WM, Leitão-Filho HF. 2001. Floração, frutificação e síndrome de dispersão de uma comunidade de brejo na região de Campinas (SP). Acta Botânica Brasílica, Porto Alegre, 15(3):349-368.

Stevenson PR, Castellanos MC, Cortés AI, Link A. 2008. Flowering patterns in a seasonal tropical lowland forest in western Amazônia. Biotropica 40(5): 559-567.

Talora DC, Morellato LPC. 2000. Fenologia de espécies arbóreas em floresta de planície litorânea do sudeste do Brasil. Revista Brasileira de Botânica, 23(1):13-26.

Teixeira AP, Assis MA. 2009. Relação entre heterogeneidade ambiental e distribuição de espécies em uma floresta paludosa no Município de Cristais Paulista, SP, Brasil. Acta Botânica Brasílica, Porto Alegre, 23(3)843:853.

Wright, S.J. Phenological responses to seasonality in tropical forest plants. 1996. In: Mulkey SS, Chazdon RL, Smith AP. (Ed.). Tropical forest plant ecophysiology. New York: Chapman & Hall.

Figure 1 - Monthly precipitation and number of flowering individuals in the shurb-tree community, from June 2009 to December 2010, in a swamp forest in the municipality of Bauru, SP.

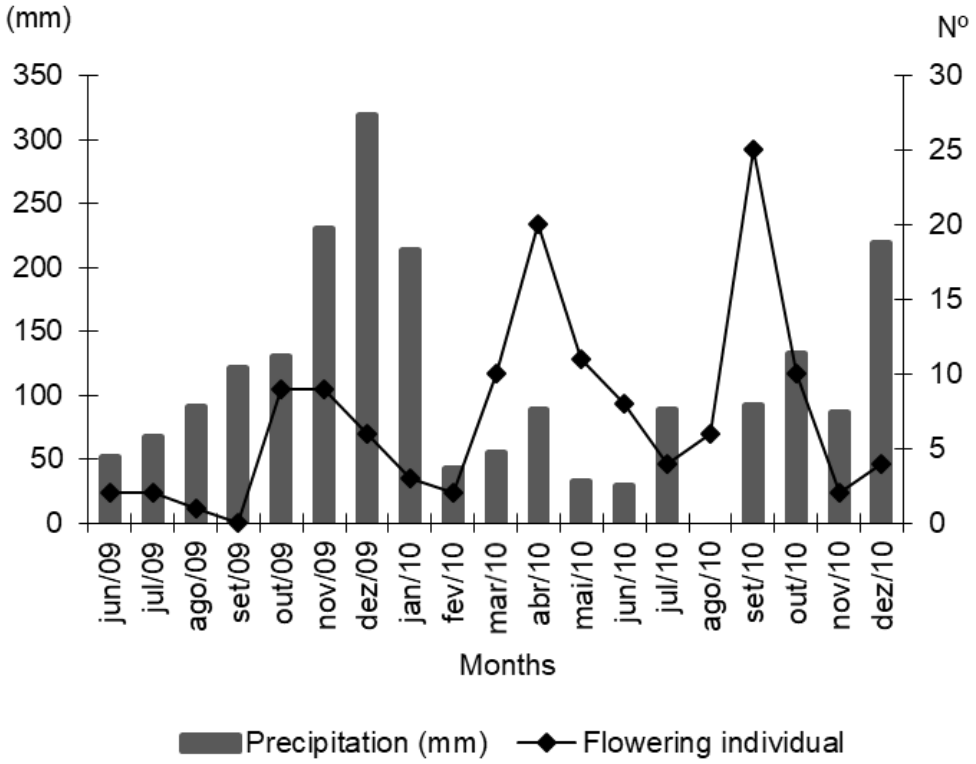

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Figure 2.A Monthly variation graphics of absolute flowering frequency of each specie.

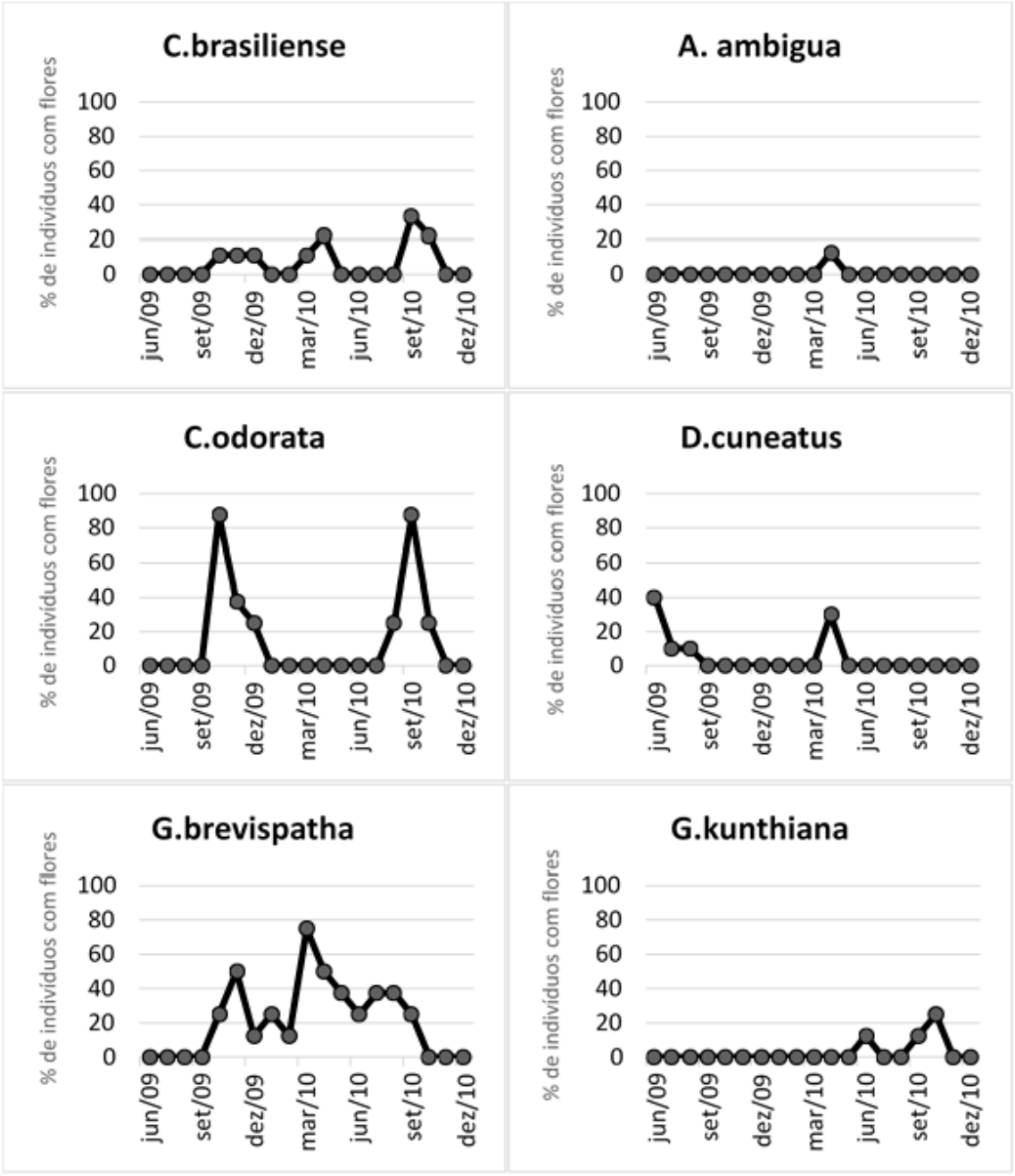

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Figure 2.B Monthly variation graphics of absolute flowering frequency of each specie.

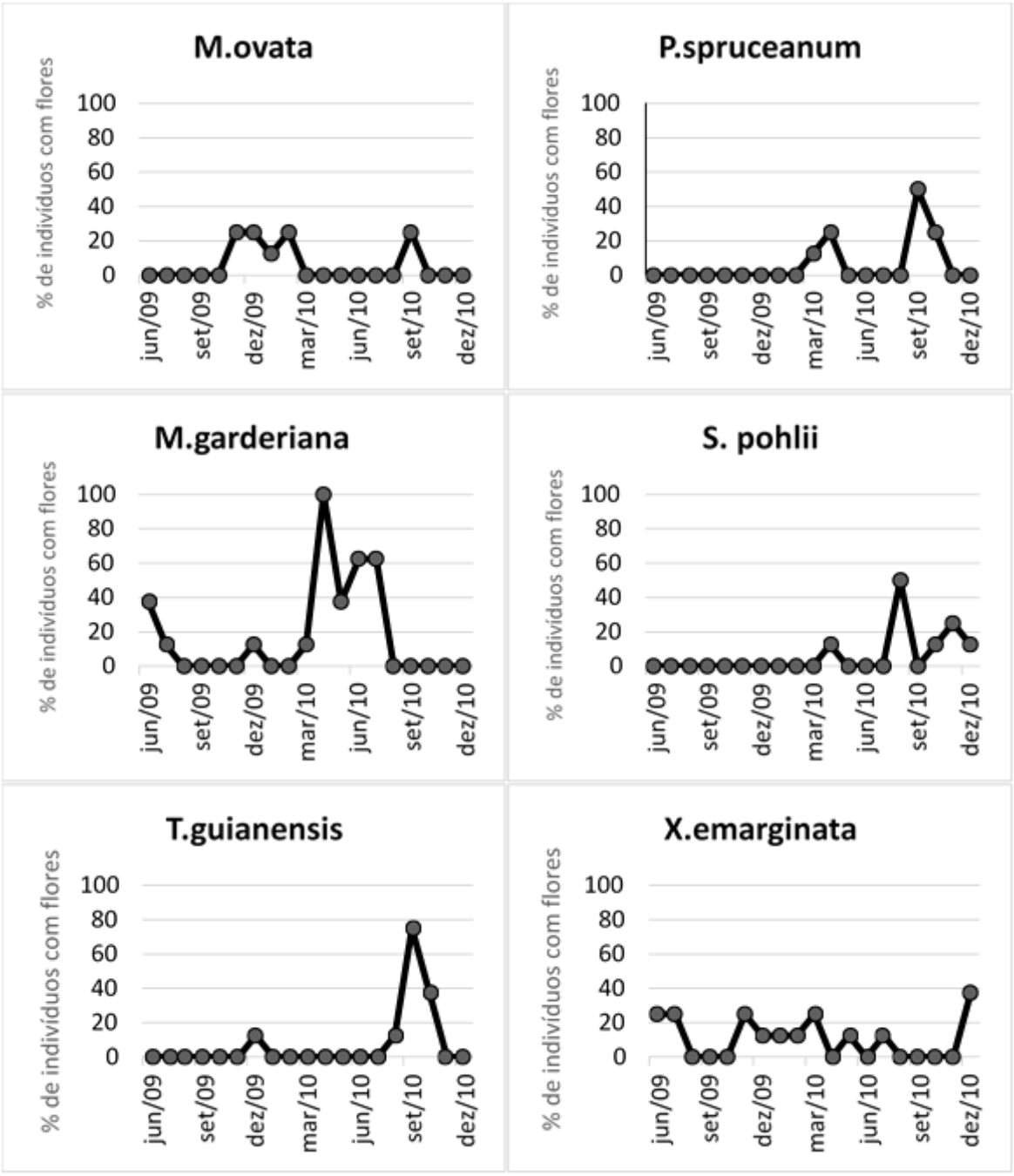

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Figure 3 - Number of individuals in process of flowering phenophases, each of the twelve analyzed shurbs-trees species, from June 2009 to December 2010 in a swamp forest in Bauru, SP.

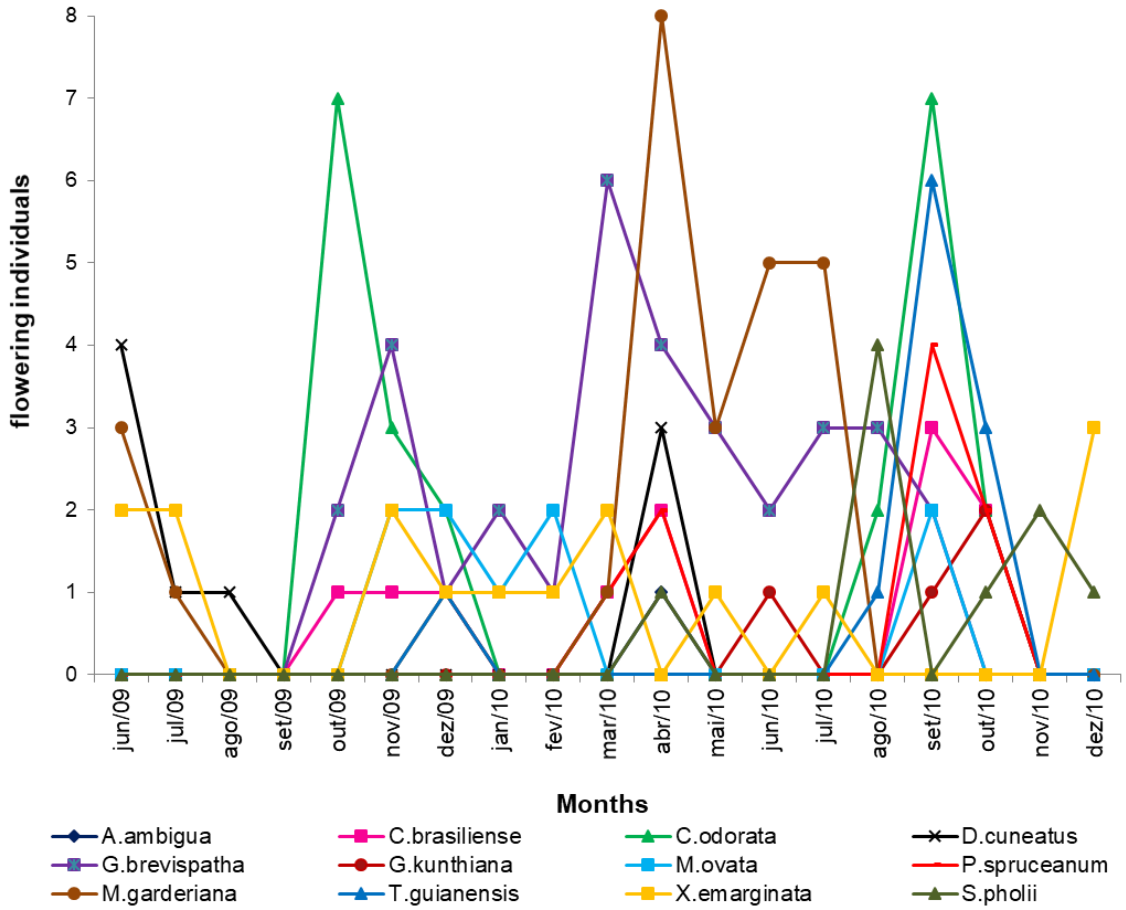

Table 1 - Flowering period, fruiting, estimates of the number of accumulated seeds and dispersal syndrome of the twelve species analyzed in a swamp forest in Bauru, SP, from 2009 to 2010 (19 months), organized in descending order by its estimated number of produced seeds in the period

Species	ıwering period	Fruiting	N° of seeds	Dispersal Syndrome
Myrsine gardneriana DC.	mar-jul	jun-mar	16.487	zoochoric
Xylopia emarginata Mart.	nov-jul	mar-jan	11.643	zoochoric
Ardisia ambigua Mart.	apr-may	jun-oct	8.597	zoochoric
Dendropanax cuneatus (DC.) Decne.& Planch.	jun-aug	jul-oct	7.494	zoochoric
Magnolia ovata (A.St.- Hil.) Spreng.	jan/sep	feb-aug	6.990	zoochoric
Calophyllum brasiliense Cambess.	mar-apr/ sep-oct	jun-jan	4.129	zoochoric
Protium spruceanum (Benth.) Engl.	mar-apr/ sep-oct	jul-jan	3.192	zoochoric
Tapirira guianensis Aubl.	aug-oct	nov-dec	2.744	zoochoric
Cedrela odorata L.	aug-dec	nov-jan	800	anemochoric

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Styrax pohlii A.DC.	sep-dec	sep-dec	232	zoochoric
Guarea kunthiana A. Juss.	jun-oct	jun-nov	140	zoochoric
Geonoma brevispatha Barb. Rodr.	sep-jun	dec-apr	109	zoochoric

Figure 4 - Monthly precipitation and number of fruiting individuals in the shurb-tree community, from June 2009 to December 2010, in a swamp forest in the municipality of Bauru, SP.

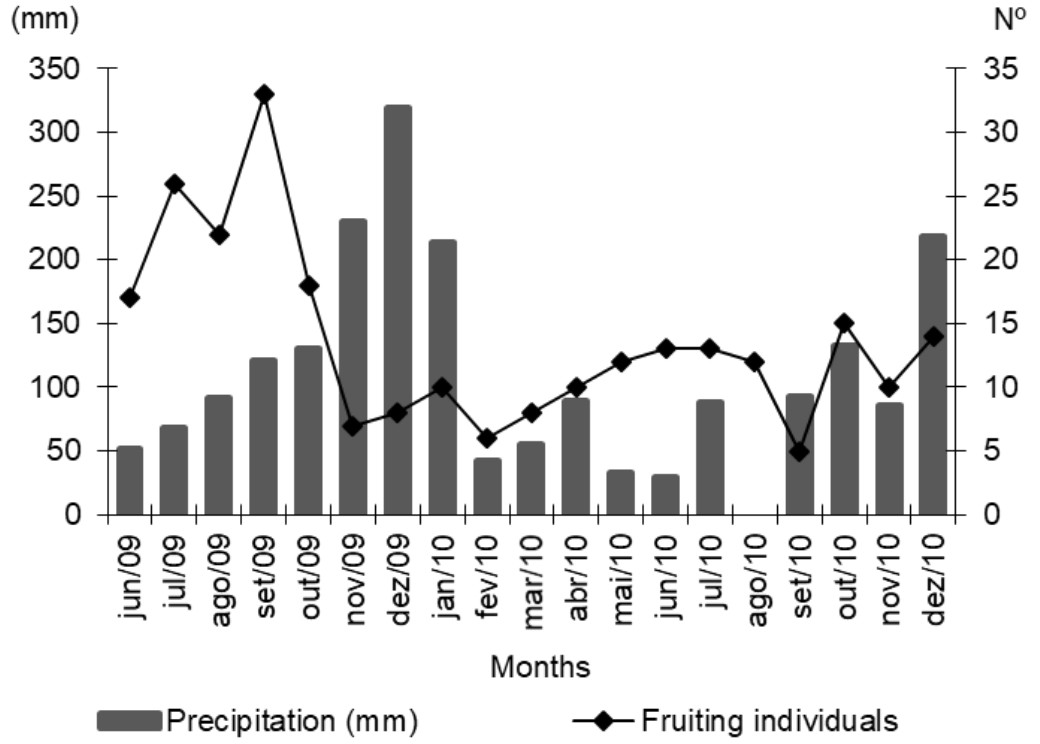

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Figure 5 - Number of individuals in process of fruiting phenophases, each of the twelve analyzed shurbs-trees species, from June 2009 to December 2010 in a swamp forest in Bauru, SP.