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Seed bank from different successional stages in the Fonte Grande State Park, ES, Brazil

Banco de sementes de diferentes estágios sucessionais no Parque Estadual da Fonte Grande, ES, Brasil

Tatiana Pizetta **DIAS**[1, 7]; Larissa Regina **TOPANOTTI**[2]; Fernando Campanhã **BECHARA**[3]; Luiz Fernando Silva **MAGNAGO**[4]; Izaclaudia Santana da **CRUZ**[5] & Marcelo **SIMONELLI**[6]

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ABSTRACT
This investigation aimed to determine the density of viable seeds and to compare the floristic composition of the seed bank from different forest successional stages – initial and intermediate – at the Fonte Grande State Park, Vitória, state of Espírito Santo, Brazil. Samples of 15 × 15 × 5 cm of soil and litter were collected, in 15 points, in each successional stage. After five months cultivating these samples in a greenhouse for botanical identification, the soil showed higher seedlings density and richness of species than the litter. A total of 1,414 seedlings was quantified: 78.3% of the individuals were in the initial stage (μ = 3,280 seedlings.m-2), and 21.7% were in the intermediate stage (μ = 910 seedlings.m-2). The richness of species between the stages was similar (53.2%), 33 species occurring in both areas. The predominant life form in both stages was herbaceous, though the intermediate stage presented more trees. These patterns indicate an early phase of the intermediate stage, which, over the successional time, will probably advance to an old-growth forest.
Keywords: Atlantic rain forest; floristic composition; regeneration; tropical forest.

RESUMO
Este estudo foi realizado com as finalidades de determinar a densidade de sementes viáveis e comparar a composição florística do banco de sementes de diferentes estágios – inicial e intermediário – de sucessão florestal no Parque Estadual da Fonte Grande, Vitória, ES. Foram coletadas amostras de 15 × 15 × 5 cm de solo e de serapilheira, de 15 pontos, em cada estágio sucessional. Após cinco meses cultivando o material em viveiro para identificação botânica, o solo apresentou maior densidade de plântulas e riqueza de espécies que a serapilheira. Foram quantificadas 1.414 plântulas, sendo 78,3% dos indivíduos pertencentes ao estágio inicial (μ = 3.280 plântulas.m-2) e 21,7% do estágio intermediário (μ = 910 plântulas.m-2). A riqueza de espécies entre os estágios foi relativamente semelhante (53,2%), sendo 33 espécies comuns a ambos. A forma de vida predominante nas duas áreas foi a herbácea, apesar de o estágio intermediário exibir mais espécies arbóreas do que o inicial. Esse padrão indica uma fase inicial do estágio intermediário de regeneração, o qual, por meio do processo sucessional, provavelmente avançará para uma floresta madura.
Palavras-chave: composição florística; floresta tropical; mata atlântica; regeneração.

[1] Elementus S.A., Av. Rio Branco, 384, Santa Lúcia – CEP 29056-264, Vitória, ES, Brazil.
[2] Universidade Federal de Santa Catarina (UFSC), Curitibanos, SC, Brazil.
[3] Universidade Tecnológica Federal do Paraná (UTFPR), Curitiba, PR, Brazil.
[4] Universidade Federal do Sul da Bahia (UFSB), Itabuna, BA, Brazil.
[5] Instituto Federal de Educação, Ciência e Tecnologia da Bahia (IFBA), Salvador, BA, Brazil.
[6] Instituto Federal do Espírito Santo (Ifes), Vitória, ES, Brazil.
[7] Corresponding author: laratopanotti@hotmail.com

INTRODUCTION

Despite the advanced degradation process, the Atlantic rain forest still harbors an important amount of the Brazilian biological diversity and its endemism, including that of the Espírito Santo state. This biodiversity is recognized by the two greatest world records of botanic richness for woody plants registered in Atlantic forest (MITTERMEIER *et al*., 2005).

Basic botanical knowledge for conservation and restoration of these remaining forest remnants is crucial to help these environments manage ecological processes and resilience. Seed bank studies can predict the potential for natural regeneration in the face of various disturbances (natural or anthropogenic). This information subsidizes investigations about three floristic aspects: composition, species relative abundance, and potential distribution of each species (HALL & SWAINE, 1980; WELLING *et al*., 1988). Therefore, seed banks are potential indicators of the resilience of forest ecosystems (BAIDER *et al*., 1999; ARAÚJO *et al*., 2001; COSTALONGA *et al*., 2006; SOUZA *et al*., 2006; BRAGA *et al*., 2008).

The seed bank is a storage of viable, non-germinated seeds, which can replace annual and perennial plants that die out due to natural or unnatural causes, diseases, disturbance, or animal consumption (BAKER, 1989; SCHORN *et al*., 2013). The seed bank plays a fundamental role in the regeneration of the gaps of the different stages of succession. In addition, it is an extremely important part of genetic conservation and related to at least four processes: population establishment, maintenance of species diversity, establishment of ecological groups, and restoration of species richness during forest regeneration after natural or anthropic disturbances (GARWOOD, 1989).

This study was conducted to determine if there were differences between the viable seeds density and the species composition in the soil and litter seed banks, from initial to medium successional stages, in an urban remnant park of Atlantic rain forest in Southeastern Brazil.

MATERIAL AND METHODS

Fonte Grande State Park is a remnant of secondary vegetation of a mountain forest, classified as dense rain forest. It has the area of 218 ha and it is located between the coordinates 20°18’11” and 20°04’00” NW, and 40°20’02” and 40°20’39” S, at the metropolitan area of Vitória, Espírito Santo state, Southeast Brazil (Figure 1). According to Köppen’s classification, the climate is humid-dry tropical, type Aw, characterized by most precipitation occurring in summer and less precipitation during winter (ALVARES *et al*., 2013). The area shows a specific dynamic, conditioned by the Atlantic tropical airflow, warm and humid, and by the Atlantic polar airflow, cold and dry, which is observed mainly in the winter.

Figure 1 – Aerial view of the Maciço Central environmental protection area (APA) surrounding the Fonte Grande State Park (Parque Estadual da Fonte Grande).

Source: Municipal Office of Environment, Vitoria, ES.

In May 2010, 15 samples of soil and litter were collected from areas in two different stages of forest succession: initial (treatment 1), and intermediate (treatment 2). In each one of the areas, the samples were collected in three transects, distant 50 m apart, with five sample points every 20 m *per* transect. The samples were taken using a square frame of 15 × 15 × 5 cm, collecting first the litter plus 5 cm of topsoil, representing a sampled area, in each treatment, of 0.3375 m^2 and the total sampled area of 0.675 m^2.

Afterwards, the samples were transposed to trays measuring 56 × 34 × 15 cm, with an 8-cm layer of nursery vermiculite plus a 3-cm layer of crushed white stone. Samples were cultivated in a greenhouse for botanic identification of the emerging seedlings. The collected litter has been sieved beforehand, before sowing. The seed bank quantity and composition were estimated using the seedlings emergence in the incubated soil, which detects only the viable seeds, in order to not overestimate the amount of the seeds in the seed bank. The evaluations were made every 15 days. The experiment took place from May to November 2010. After the identification, the seedlings were removed from the trays and replanted in plastic bags. During the experiment, the soil samples were revolved to facilitate the possible germination of the highest number of viable seeds.

The found records were compared with the collection of the Universidade Federal do Espírito Santo Herbarium, and the Angiosperm Phylogeny Group (APG) II (2009) botanical system was followed. The identified species were classified according to their life form as: herbs, sub-shrubs, shrubs, and trees. The absolute and relative density and the Sorensen similarity index (ISS) were calculated, in order to compare the floristic similarity between the treatments, as described by Müller-Dombois & Ellemberg (1974).

RESULTS

The total of 1,541 seedlings emerged from both areas and were quantified, and 8.2% of them died during the evaluation period. Considering the alive seedlings (1,414 individuals), 44.2% were identified to the species level, 33.3% were identified to the genus level, 13.3% to the family level, and 9.2% could not be identified to any level (Table 1). Thus, the seedlings were identified into 22 botanical families, 38 species, and 91 morphospecies.

Table 1 – Botanical identification of seedlings emerged from the seed banks of two different succession stages – initial and intermediate – in the Fonte Grande State Park, Vitória, ES, Brazil.

			Initial stage			Intermediate stage				
Scientific name	**Family**	**LF**	**SO**	**LI**	**DEN**	**SO**	**LI**	**DEN**	**N**	**DEN (%)**
Talinum fruticosum	Talinaceae	H	239	112	1,040.0	2	1	8.9	354	25
Amaranthus sp. 2	Amaranthaceae	H	185	21	610.4	-	-	-	206	14.6
Amaranthus sp. 1	Amaranthaceae	H	138	2	414.8	-	-	-	140	9.9
Cyperaceae sp. 3	Cyperaceae	H	3	-	8.9	71	1	213	75	5.3
Amaranthus sp. 4	Amaranthaceae	H	49	15	189.6	-	-	-	64	4.5
Acalypha communis	Euphorbiaceae	H	52	2	160.0	-	-	-	54	3.8
Indeterminate sp. 1	Indeterminate	I	8	5	38.5	29	3	95	45	3.2
Euphorbia hirta L.	Euphorbiaceae	H	2	6	23.7	11	15	77	34	2.4
Amaranthus sp. 3	Amaranthaceae	H	17	5	65.2	-	-	-	22	1.6
Talinum paniculatum	Talinaceae	H	11	8	56.3	3	-	8.9	22	1.6
Cyperaceae sp. 2	Cyperaceae	H	12	6	53.3	3	-	8.9	21	1.5
Cecropia sp. 2	Urticaceae	T	13	1	41.5	6	-	18	20	1.4

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Continuation of the table 1

			Initial stage			Intermediate stage				
Scientific name	**Family**	**LF**	**SO**	**LI**	**DEN**	**SO**	**LI**	**DEN**	**N**	**DEN (%)**
Commelina benghalensis	Commelinaceae	H	16	2	53.3	1	-	3	19	1.3
Phyllanthus tenellus	Phyllanthaceae	H	13	5	53.3	-	1	3	19	1.3
Poaceae sp. 1	Poaceae	H	4	3	20.7	7	3	30	17	1.2
Indeterminate sp. 3	Indeterminate	I	10	5	44.4	-	-	-	15	1.1
Poaceae sp. 2	Poaceae	H	14	-	41.5	1	-	3	15	1.1
Urticaceae sp. 1	Urticaceae	I	-	-	-	13	1	41	14	1
Euphorbia prostrata	Euphorbiaceae	H	3	5	23.7	5	1	18	14	1
Malvastrum coromandelianum	Malvaceae	SS	6	5	32.6	2	-	5.9	13	0.9
Indeterminate sp. 8	Indeterminate	I	-	-	-	5	7	36	12	0.8
Pteridium aquilinum	Dennstaedtiaceae	H	5	-	14.8	6	-	18	11	0.8
Indeterminate sp. 9	Indeterminate	I	3	-	8.9	4	3	21	10	0.7
Verbenaceae sp. 1	Verbenaceae	I	7	3	29.6	-	-	-	10	0.7
Cecropia sp. 1	Urticaceae	T	-	-	-	9	-	27	9	0.6
Leandra purpurascens	Melastomataceae	S	2	-	5.9	7	-	21	9	0.6
Asteraceae sp. 1	Asteraceae	I	-	1	3	4	2	18	7	0.5
Emilia fosbergii	Asteraceae	H	5	1	17.8	-	-	-	6	0.4
Vernonia sp.	Asteraceae	I	3	3	17.8	-	-	-	6	0.4
Cyperaceae sp. 4	Cyperaceae	H	-	2	5.9	-	4	12	6	0.4
Indeterminate sp. 11	Indeterminate	I	1	4	14.8	-	1	3	6	0.4
Tarenaya hassleriana	Cleomaceae	SS	-	-	-	3	3	18	6	0.4
Phyllanthus niruri	Phyllanthaceae	H	4	1	14.8	1	-	3	6	0.4
Poaceae sp. 5	Poaceae	H	6	-	17.8	-	-	-	6	0.4
Indeterminate sp. 6	Indeterminate	I	3	2	14.8	-	-	-	5	0.4
Portulaca oleracea	Portulacaceae	H	2	1	8.9	1	1	5.9	5	0.4
Cyrtocymura scorpioides	Asteraceae	SS	3	1	11.9	-	-	-	4	0.3
Begonia semperflorens	Begoniaceae	H	1	-	3	3	-	8.9	4	0.3
Indeterminate sp. 13	Indeterminate	I	2	1	8.9	-	1	3	4	0.3
Vernonia polyanthes	Asteraceae	T	-	-	-	3	1	12	4	0.3
Rubiaceae sp. 2	Rubiaceae	H	-	-	-	4	-	12	4	0.3
Indeterminate sp. 19	Indeterminate	I	-	-	-	4	-	12	4	0.3
Piper umbellatum	Piperaceae	SS	-	1	3	3	-	8.9	4	0.3
Melampodium perfoliatum	Asteraceae	H	3	-	8.9	-	-	-	3	0.2
Tarenaya spinosa	Cleomaceae	SS	1	2	8.9	-	-	-	3	0.2

to be continued...

Continuation of the table 1

			Initial stage			Intermediate stage				
Scientific name	**Family**	**LF**	**SO**	**LI**	**DEN**	**SO**	**LI**	**DEN**	**N**	**DEN (%)**
Euphorbia heterophylla	Euphorbiaceae	H	-	1	3	1	1	5.9	3	0.2
Euphorbiaceae sp. 1	Euphorbiaceae	H	1	-	3	2	-	5.9	3	0.2
Indeterminate sp. 24	Indeterminate	I	1	2	8.9	-	-	-	3	0.2
Indeterminate sp. 5	Indeterminate	I	1	-	3	1	1	5.9	3	0.2
Malvaceae sp. 1	Malvaceae	I	-	-	-	1	2	8.9	3	0.2
Thalia geniculata	Marantaceae	H	-	-	-	3	-	8.9	3	0.2
Indeterminate sp. 20	Indeterminate	I	-	-	-	3	-	8.9	3	0.2
Indeterminate sp. 21	Indeterminate	I	-	-	-	2	1	8.9	3	0.2
Setaria parviflora	Poaceae	H	1	2	8.9	-	-	-	3	0.2
Rubiaceae sp. 1	Rubiaceae	H	1	-	3	2	-	5.9	3	0.2
Solanum americanum	Solanaceae	H	1	1	5.9	-	1	3	3	0.2
Phenax sonneratii	Urticaceae	H	1	-	3	2	-	5.9	3	0.2
Crepis japonica	Asteraceae	H	2	-	5.9	-	-	-	2	0.1
Indeterminate sp. 2	Indeterminate	I	1	-	3	1	-	3	2	0.1
Indeterminate sp. 4	Indeterminate	I	1	-	3	1	-	3	2	0.1
Sapium haematospermum	Euphorbiaceae	T	-	-	-	2	-	5.9	2	0.1
Mollugo verticillata	Molluginaceae	H	2	-	5.9	-	-	-	2	0.1
Indeterminate sp. 10	Indeterminate	I	-	-	-	1	1	5.9	2	0.1
Solanum sp.	Solanaceae	I	-	1	3	-	1	3	2	0.1
Bidens subalternans	Asteraceae	H	-	1	3	-	-	-	1	0.1
Porophyllum ruderale	Asteraceae	H	-	1	3	-	-	-	1	0.1
Indeterminate sp. 16	Indeterminate	I	1	-	3	-	-	-	1	0.1
Indeterminate sp. 17	Indeterminate	I	1	-	3	-	-	-	1	0.1
Indeterminate sp. 18	Indeterminate	I	-	1	3	-	-	-	1	0.1
Indeterminate sp. 26	Indeterminate	I	-	1	3	-	-	-	1	0.1
Poaceae sp. 3	Poaceae	H	1	-	3	-	-	-	1	0.1
Borreria verticillata	Rubiaceae	H	1	-	3	-	-	-	1	0.1
Erechtites valerianifolius	Asteraceae	H	-	-	-	1	-	3	1	0.1
Gnaphalium coarctatum	Asteraceae	H	-	-	-	-	1	3	1	0.1
Cestrum sp.	Solanaceae	S	1	-	3	-	-	-	1	0.1
Cyperus distans	Cyperaceae	H	-	-	-	1	-	3	1	0.1
Cyperaceae sp. 1	Cyperaceae	H	-	-	-	-	1	3	1	0.1
Senna occidentalis	Fabaceae	S	-	-	-	-	1	3	1	0.1
Peperomia pellucida	Piperaceae	H	-	-	-	-	1	3	1	0.1
Datura stramonium	Solanaceae	H	1	-	3	-	-	-	1	0.1
Poaceae sp. 4	Poaceae	H	-	-	-	1	-	3	1	0.1

to be continued...

Continuation of the table 1

			Initial stage			Intermediate stage				
Scientific name	**Family**	**LF**	**SO**	**LI**	**DEN**	**SO**	**LI**	**DEN**	**N**	**DEN (%)**
Rubiaceae sp. 3	Rubiaceae	I	-	-	-	1	-	3	1	0.1
Cecropia sp. 3	Urticaceae	T	-	-	-	1	-	3	1	0.1
Pilea microphylla	Urticaceae	H	-	-	-	1	-	3	1	0.1
Indeterminate sp. 7	Indeterminate	I	-	-	-	1	-	3	1	0.1
Indeterminate sp. 12	Indeterminate	I	-	-	-	1	-	3	1	0.1
Indeterminate sp. 14	Indeterminate	I	-	-	-	-	1	3	1	0.1
Indeterminate sp. 15	Indeterminate	I	-	-	-	1	-	3	1	0.1
Indeterminate sp. 22	Indeterminate	I	-	-	-	1	-	3.0	1	0.1
Indeterminate sp. 23	Indeterminate	I	-	-	-	-	1	3.0	1	0.1
Indeterminate sp. 25	Indeterminate	I	-	-	-	1	-	3.0	1	0.1
Total = 91			**865**	**242**	**3,280**	**244**	**63**	**910**	**1,414**	**100**

LF: life form; SO: soil seed bank; LI: litter seed bank; DEN: absolute density (individuals.m^{-2}); N: number of seedlings; DEN (%): relative density (%); H: herb; SS: sub-shrub; S: shrub; T: tree; I: indeterminate.

Among the total alive seedlings, 78.3% emerged from the initial stage of succession (1,107), and 21.7% emerged from the intermediate stage (307). The absolute density of seedlings was higher in the initial stage area (3,280 seedlings.m^{-2}) than in the intermediate stage (910 seedlings.m^{-2}).

The richest families, typical from early succession stages, were Asteraceae (11 spp.), followed by Euphorbiaceae, Poaceae, and Urticaceae, with six species each. The species with the highest density, regardless of the successional stage, were *Talinum fruticosum* (L.) Juss., with 354 individuals (25%), *Amaranthus* sp. 2, with 206 individuals (14.6%), and *Amaranthus* sp. 1, with 140 individuals (9.9%). From these, the only species that occurred in both areas were *T. fruticosum*, and the two *Amaranthus* species occurred only in the initial area. The other species showed individual density of less than 5.5%.

About the same number of species was observed in both stages. However, 28 species were verified only in the initial stage and 30 species only in the intermediate stage. The total of 33 species occurred simultaneously in both areas, representing the SSI of 53.2%.

Considering the two areas separately, in the initial stage, the richest family was Asteraceae (eight species), followed by Poaceae and Euphorbiaceae, with five species each. The species with the highest absolute and relative density in the area was *T. fruticosum*, with the absolute density of 1,040 seedlings.m^{-2}.

The richest family in the intermediate stage was Urticaceae, with six species, followed by Cyperaceae (five species). The densest species in this area was Cyperaceae sp. 3 (213.3 seedlings.m^{-2}).

The seed banks of both stages presented species in all life forms, but the herbaceous species were the most representative (49.5%) among the 91 morphospecies.

In the initial stage, the herbaceous species summed up 90.4% of the total seedlings that emerged. In the soil layer, this life form recorded 92% of the seedlings and, in the litter layer, 83.9% of the seedlings. The most representative herbaceous species were *T. fruticosum* and *Amaranthus* spp. 2 and 1, with 1,040.0, 610.4, and 414.8 seedlings.m^{-2}, respectively (Table 1).

In the intermediate stage, the herbaceous species corresponded to 54.1% of the germinated seedlings. These species represented 54.5% of the seedlings in the soil layer, and 52.4% of the seedlings in the litter layer. The most representative herbs in this area were Cyperaceae sp. 3 (213.3 seedlings.m^{-2}), *Euphorbia hirta* (77 seedlings.m^{-2}) and Poaceae sp. 1 (29.6 seedlings.m^{-2}).

Among the five tree species found in the study, all of them were only present at the intermediate stage, and only *Cecropia* sp. 2 was also recorded in the initial phase.

The soil samples presented higher density and number of species than the litter layer.

In the initial stage, 52 species were observed in the soil layer, representing the absolute density of 2,563 seedlings.m^{-2} (78.1%). In the intermediate stage, the total of 51 species was verified in the soil layer, which summed up 723 seedlings.m^{-2} and 79.5% of the relative density of the area.

In both areas, the highest proportion of seedlings was observed in the first month of evaluation (June), and the number of emerged seedlings reduced gradually in the following four months. The seedlings germinated in June represented 58% of the total in the intermediate stage and 71% in the initial stage (Figure 2).

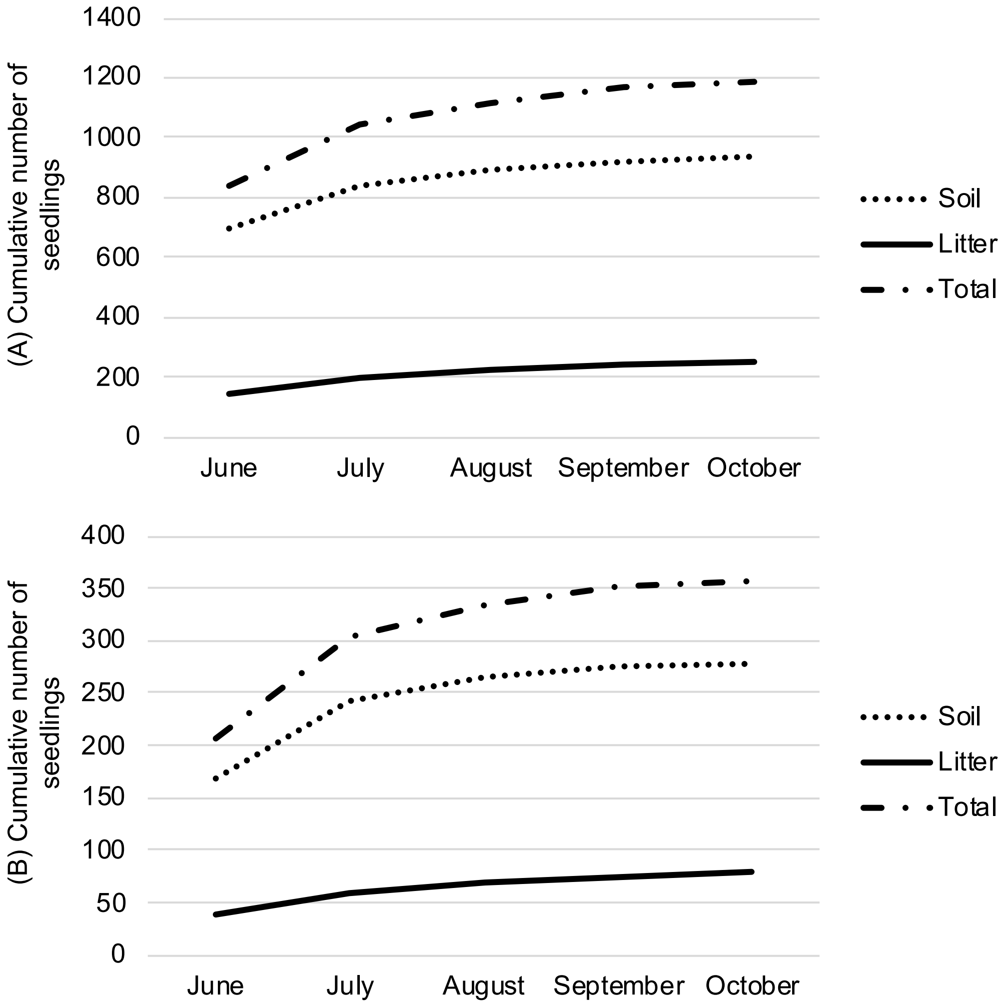

Figure 2 – Cumulative number of emerged seedlings in (A) the initial and (B) the intermediate stage.

Source: primary.

DISCUSSION

Surprisingly, the initial and intermediate stages showed similar richness, around 60 species, falling within the pattern recorded by Garwood (1989), who detected a range from four to 67 species in tropical environments. It points out an early intermediate stage of the area, whereas its richness can still develop in a successional time. On the other hand, the density of seedlings in the initial stage area was higher, indicating that the number of viable seeds decreased with the successional stage.

The higher number of seedlings from seed banks of initial stage areas can be related to positively photoblastic seeds, typical for pioneer species. These results corroborate other authors' studies in tropical forests, such as Young *et al*. (1987), Leal Filho (1992), Vieira (1996), Araújo *et al*. (2001), Baider *et al*. (2001), and Schorn *et al*. (2013).

However, the density verified on the initial stage (3,280 seedlings.m^{-2}) was higher than the values found by other authors in other initial stage successional areas. Leal Filho (1992) registered the density of 2,216 seeds.m^{-2} in a pasture area in Minas Gerais state. The density found by the present investigation in the intermediate stage (909.6 seedlings.m^{-2}) was similar to the one Baider *et al*. (1999) found, 872 seeds.m^{-2} in the seed bank of a tropical montane forest. According to Saulei & Swaine (1988), the seed bank of a primary tropical forest usually shows a density of less than 500 seeds.m^{-2}. However, Garwood (1989) argues that the density of seeds is higher and that it oscillates between 25 to 3,350 seeds.m^{-2}, while initial stage forests and agriculture and/or pasture lands present the density from 48 to 18,900 seeds.m^{-2}. The total density of seedlings in the present study followed this pattern.

The most common life form in both regions was herbaceous. Herbs represented around 50% of the total species observed in this study, and more than 90% of the total of individuals registered in the initial successional stage. According to Garwood (1989) and Hopkins *et al*. (1990), pioneer herbaceous species with small seeds are frequently and greatly found in seed banks, and they can represent 25 to 90% of the total species in the seed bank. Baider *et al*. (1999) noticed that the herbaceous species were the most common in their study in a tropical montane forest in São Paulo. Other investigations also showed herbaceous plants as the predominant ones on the seed banks (SCHORN *et al*., 2013). The herbaceous species are significant to forest ecosystems, promoting soil conservation through protection against the direct action of raindrops, solar radiation, and wind. Besides, their roots prevent erosion and work as a source of organic matter. All these functions enable the establishment of other species during the natural regeneration process.

All observed tree species were verified at the intermediate stage, and only one was also seen at the initial stage of succession. This follows a common pattern: most advanced successional stages tend to present more woody and arboreal species. Baider *et al*. (2001) affirmed that, as the forest became older, the density of woody plant species in the seed bank increased. Souza *et al*. (2017), studying a preserved and advanced forest remnant of rain forest (dense ombrophilous forest) in São Paulo state, demonstrated predominance of arboreal species, with relative density of 50%.

Regarding the botanical families, Urticaceae, Euphorbiaceae, and Cyperaceae were the richest in the intermediate stage area, while in the initial stage area these families were Asteraceae, Poaceae, and Euphorbiaceae. These families are common and greatly found in the seed banks of tropical forests early stages (SCHORN *et al*., 2013). Poaceae, Euphorbiaceae, Asteraceae, and Cyperaceae were among the most representative families in *caatinga* areas as well (FERREIRA *et al*., 2014). Asteraceae and Poaceae were the first and the third richest families of restored areas of semideciduous seasonal forest in Minas Gerais state (GUIMARÃES *et al*., 2014), and they were the two richest families in the research conducted by Baider *et al*. (2001).

A higher density and richness of species were observed in the soil samples in both stages, probably because the litter layer is more exposed to seed consumption by animals and pathogens. Baider *et al*. (1999), when assessing the distribution of seeds along the soil profile, detected that 65% of the germinated seeds were within 0-2.5 cm of depth and the other 35% was observed within 2.5-5 cm of depth. Vieira (1996) verified that the density of seeds was higher in the 0-5 cm soil, and the density of seeds at lower depth (5-10 cm) was about half of that found in the topsoil. Lopes *et al*. (2006) noticed the highest density of viable seeds in the 0-5 cm layer, which was twice higher than the number of germinated seeds in the 5-10 cm layer. These studies highlight a significant decrease of viable seeds with the soil depth increase. They also reinforce the hypothesis that the highest number of viable seeds occurs in the first 5 cm on the soil profile, which was the depth adopted in this study to collect the samples.

The ISS observed in this study (53.2%) shows two floristically similar communities (MÜLLER-DOMBOIS & ELLEMBERG, 1974) among the successional stages. It indicates that their seed banks have the potential to start the succession process and recolonize gaps after some disturbance.

In terms of the germination over time, the highest rates of germination were verified in the first month of evaluation. Commonly, the highest rates of seed germination occur in the first month (ARAÚJO *et al*., 2001; SIQUEIRA, 2002; COSTA & ARAÚJO, 2003; ALVARENGA *et al*., 2006) up to the first four months (CALDATO *et al*., 1996; VIEIRA, 1996), as observed in our study.

CONCLUSION

The initial stage presented higher density of viable seeds than the intermediate stage seed bank, although about half of the species was similar. The predominant life form in both areas was herbaceous, though the intermediate stage presented more trees compared to the initial stage. These patterns indicate an early phase of the intermediate stage, which, over the successional time, will probably advance to an old-growth forest. The soil showed higher seed density and richness of species than the litter. It is recommended a longer monitoring, which would probably increase the number of emerged seedlings over time.

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