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Genetic resources of mangabeira (*Hancornia speciosa* Gomes) in protected areas in Brazil

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Abstract - Brazil, a recognized country for its rich biodiversity, is also known for the rapid loss of a significant part of its *in situ* genetic resources. Among hundreds of native species that have great potential for economic exploitation, many are not yet acknowledged or are yet to be described. The mangabeira (*Hancornia speciosa* Gomes) is a fruit tree at the begging of the domestication process and has enormous economic potential. However, it is being affected by genetic erosion. In this communication, we describe five populations of mangabeira located in distinct protected areas in the Midwest and Northeast regions of Brazil, where the varieties *speciosa* and *pubescens* occur. We show that even in protected areas, mangabeira plants are not in the best situation for conservation. The areas are located in diverse biomes and environmental conditions; therefore, such populations provide an opportunity to improve the knowledge about the species and map its areas of occurrence. We highlight the relevance of maintaining mangabeira populations as reservoirs of genetic resources, which leverage the utilization of the genetic variability of this species. These descriptions highlight the significant importance of maintaining protected areas as a suitable strategy for *in situ* conservation.
Index terms: mangaba, *in-situ* conservation, native fruits, conservation units.

Recursos genéticos de mangabeira (*Hancornia speciosa* Gomes) em áreas protegidas no Brasil

Resumo - O Brasil é um país reconhecido por sua rica biodiversidade, mas também pela rápida perda de parte significativa de seus recursos genéticos *in situ*. Entre centenas de espécies nativas que apresentam grande potencial de exploração econômica, muitas ainda não são reconhecidas ou ainda não foram descritas. A mangabeira (*Hancornia speciosa* Gomes) é uma árvore frutífera que se encontra no início do processo de domestificação e possui enorme potencial econômico. No entanto, está sendo afetada pela erosão genética. Neste trabalho, são descritas cinco populações de mangabeira localizadas em distintas unidades de conservação, nas regiões Centro-Oeste e Nordeste do Brasil, onde ocorrem as variedades *pubescens* (típica) e *speciosa*. Mostramos que, mesmo em áreas protegidas, plantas de mangabeira não estão nas melhores condições de conservação. Como as áreas estão localizadas em biomas e em condições ambientais diversas, essas populações oferecem oportunidade para aprimorar o conhecimento sobre a espécie e para mapear suas áreas de ocorrência. Destacamos a relevância de manter as populações de mangabeira como reservatórios de recursos genéticos, o que potencializa a utilização da variabilidade genética desta espécie. Essas descrições destacam a importância significativa da manutenção de áreas protegidas como uma estratégia adequada para a conservação *in situ*.
Termos para indexação: mangaba, conservação *in situ*, frutas nativas, unidades de conservação.

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The fruit tree "mangabeira" (*Hancornia speciosa* Gomes, Apocynaceae) is a tropical species of substantial socioeconomic importance and has considerable potential for commercial exploitation in Brazil. Fruits of mangabeira are very much appreciated, either as juice, ice cream, sweets, jam and jelly (LEDERMAN et al., 2000; PEREIRA et al., 2010; SILVA JÚNIOR et al., 2017). The species occurs in four Brazilian biomes: Amazonia (rain forest covering the Amazon basin), Cerrado (savanna-like vegetation), Caatinga (a semiarid steppic-savanna), and the Atlantic Forest (rain forest occurring along the coast) and its marginal habitats vegetation on the sandy coastal plains locally called 'Restinga' (SCARANO, 2009; PEREIRA et al., 2010; KOCH et al., 2015; SILVA JUNIOR et al., 2017).

Mangabeira is at the beginning of the domestication process (SILVA et al., 2019). However, significant parts of its genetic resources are lost due to reducing native vegetation in the area of occurrence, mainly in the Cerrado, Caatinga and Atlantic Forest biomes. In the Cerrado, Machado et al. (2004) estimated that 2.2 million hectares of native vegetation are lost per year. According to Silva (2002), this reduction is primarily caused for the increase of soybean plantations and corn and eucalyptus farming and pasture. Cunha et al. (2008) also describe the intense environmental degradation in distinct areas of the Cerrado. In the Caatinga biome, the condition is similar to the Cerrado in regions where irrigation is feasible. However, according to Alves et al. (2009), the exploration of extensive pastures is the predominant anthropic disturbance. In areas where irrigation is not possible, degradation also occurs, though on a smaller scale than in the Cerrado, mainly because of the irregular and low precipitation rates in the semiarid that hinder the expansion of the large monocultures. It is essential to highlight that in both Cerrado and Caatinga biomes, in some not cultivable areas, such as the "Serra of Espinhaço Mineiro" in Minas Gerais state, the "Chapada Diamantina" in Bahia state and some protected areas, less vulnerable populations of mangabeira occur.

In the Atlantic Rain Forest, which covers coastal lowlands and coastal plateaus, mangabeira populations are highly vulnerable, mainly due to the highly fragmented situation of the biome, which happened for the establishment of sugarcane and coconut plantations, pastures and urban sprawl (MOURA et al., 2005; SILVA JUNIOR et al., 2007). Considering that natural populations of mangabeira are highly vulnerable, there is an unquestionable and urgent need to apply strategies and actions to guarantee the conservation of their genetic resources.

Since mangabeira is a tree with recalcitrant seeds, the conservation of its genetic resources is made *ex situ* in orchard germplasm banks. The germplasm collections are maintained by public companies and universities, such as: Empresa Paraibana de Pesquisa, Extensão Rural e Regularização Fundiária - Empaer (540 accessions), Embrapa Tabuleiros Costeiros (302 accessions), Embrapa Cerrados (15 accessions), Embrapa Meio-Norte (39 accessions), Universidade Federal de Goiás (191 accessions), Universidade Estadual de Goiás (400 accessions), Embrapa Amapá (86 accessions), and Universidade Federal de Alagoas (20 accessions), besides other small collections (SILVA JÚNIOR et al., 2017).

Although there has been some improvement in the number of accessions during the last years, the mentioned collections are still small. Consequently, the characterization of its genetic resources is insufficient for a species of great importance and vast occurrence, such as the mangabeira. The central difficulty for increasing the number of accessions of mangabeira is related to the size of the adult tree (up to 10 meters high), which requires large areas for the collections and results in high costs for maintenance. The characterization of accessions in the germplasm bank shares the same difficulty.

Under this context, *in situ* conservation is of fundamental importance for the conservation of mangabeira tree germplasm. Thus, the creation of new protected areas and the enlargement of the existent ones are appropriate strategies for conserving its genetic resources. However, these crucial choices are also challenging to put into practice due to the costs involved. Often, the populations occur in private lands. The implementation of protected areas depends on the owners' desire and their cooperation while competing with other conflicting economic interests.

Despite the great importance of protected areas for the conservation of genetic resources of mangabeira populations, the long-term protection of the species will be guaranteed if the areas are properly managed, which is strongly dependent on the fluctuation of political circumstances and public investment. Protected areas, known in Brazil as 'Conservation Units' (BRASIL, 2000), are vital reservoirs of genetic resources of a variety of wild animal and plant species, including some species of high economic importance such as mangabeira. Therefore, descriptions of wild populations contribute to the increase in the utilization of the mangabeira genetic resources and highlight the importance of the protected areas and their necessary support for adequate maintenance, management, and enlargement.

Researches aimed at *in situ* conservation of mangabeira involving traditional communities of mangaba pickers has been carried out by Embrapa on the coast of Northeast Brazil. The work allowed to map natural areas of occurrence of mangabeira in the states of Sergipe and Pernambuco. Also, the role of extractivism in the conservation of these fragments was assessed. Good practices were built with these populations (Silva Júnior et al., 2016), and a set of methodologies, tools and public policies was defined, which gave rise to social technology strategies for the empowerment of mangaba pickers in Sergipe (FBB, 2011).

In this communication, we describe five populations of mangabeira that occur in distinct protected areas in the Southwest and Northeast of Brazil, under distinct conservation categories, according to the International Union for Conservation of Nature- IUCN (Dudley, 2013): one strictly protected area of IUCN category I ("Reserva Biológica Guaribas - RBG"), three park-like areas of IUCN category II (the private-owned reserve "Reserva Nossa Senhora do Oiteiro de Maracaípe - RNSOM", the State Park "Parque Estadual da Lapa Grande - PELG", and the National Park "Parque Nacional da Chapada dos Veadeiros - PNCV"), and one managed area of IUCN category VI ("Floresta Nacional do Araripe - Apodi - FLONA"). All areas were visited between May 2016 and May 2017.

Out of the six botanical varieties of *H. speciosa* Gomes described by Monachino (1945), only the *speciosa* variety occurs in the protected areas in the Northeast of Brazil - RBG, RNSOM and FLONA. In the Southeast, in Minas Gerais and Goiás, where PELG and PNCV are located, Monachino (1945) reported the occurrence of the varieties *pubescens, speciosa*, *gardneri*, *maximilliani* and *lundii*. However, currently, only two varieties are recognized to occur in the area, *pubescens* and *speciosa*, according to Koch et al. (2015).

The five areas were chosen because of their location within the geographical area of the species' occurrence in Brazil and because information about its occurrence was available. In each population, 26 to 33 adult individuals within the core area of occurrence of mangabeira were georeferenced (Table1), and all sampled trees were identified with aluminium tags. There was a minimum distance of 10 m between individuals, whereas the maximum distance reached hundreds of meters, depending on the population density and size. Table 2 describes the predominant vegetation, average altitude, and climatic information of average precipitation and mean annual temperature for each protected area with the occurrence of mangabeira, according to the data bank available http://pt.climate-data.org/, based on meteorological data collected between 1982 and 2012.

Reserva Biológica Guaribas (RBG) – This most strictly protected area is located in the Municipalities of Mamanguape and Rio Tinto, State of Paraíba. It was established by the Federal Decree nº 98.884 in 1990 and is public-owned and administrated by Chico Mendes Institute for Biodiversity Conservation (ICMBio). The RBG covers 4,051.62 hectares, and the vegetation is of Atlantic Forest. The largest concentration of mangabeira trees occurs at the border of the reserve closer to the coast. The population is distributed from the proximity of the RBG administration office, extending to the area parallel to the highway BR-101 northward. It is a large population, including many young plants, which is indicative that the population is renewing. Regarding the vulnerability of this population, the primary threat is fire, primarily because part of the area is alongside a highway with heavy road traffic, being the source of frequent fires, either intentional or accidental.

RPPN Nossa Senhora do Oiteiro de Maracaípe (RNSOM) – Located in the Municipality of Ipojuca, on the southern coast of the Pernambuco state, this is a private area owned by the Saint Miguel parish. It covers 76.21 hectares, with predominant 'Restinga' vegetation and some areas of mangrove. In the area, the mangabeira population occurs along with other planted fruit trees, some native, such as guava and cashew, and some exotic, such as mango fruit and coconut. There are pieces of evidence of past solid anthropic disturbances, predominantly up to the year 2000, when the area was protected through the establishment of the RPPN.

Table 1. List of the individual plants of mangabeira visited and georeferenced at five protected areas in the Southwest and Northeast Regions of Brazil, 2016 -2017

Plant number	RBG	RNSOM	PELG	PNCV	FLONA
1	06°40'00.3" 35°06'57.6"	08°31'35.4" 35°01'13.3"	16°44'47" 43°59'57"	14°10'40.9" 47°49'52.9"	07°16'00.0" 39°29'15.0"
2	06°40'03.8" 35°06'54.6"	08°31'40.2" 35°01'10.5"	16°44'45" 43°59'55"	14°10'30.2" 47°49'54.6"	07°16'02.5" 39°29'14.0"
3	06°40'07.6" 35°06'53.6"	08°31'34.9" 35°01'08.1"	16°45'57" 43°59'36"	14°10'00.4" 47°49'54.7"	07°17'43.4" 39°29'04.0"
4	06°40'30.0" 35°06'48.8"	08°31'26.0" 35°01'03.2"	16°44'38" 43°59'39"	14°09'95.3" 47°49'60.9"	07°17'44.7" 39°29'05.0"
5	06°40'35.8" 35°06'49.4"	08°31'29.2" 35°01'02.9"	16°44'39" 43°59'38"	14°09'87.1" 47°49'72.9"	07°17'47.5" 39°20'86.0"
6	06°40'43.1" 35°07'37.9"	08°31'31.6" 35°01'02.1"	16°44'30" 43°59'36"	14°09'91.1" 47°49'86.2"	07°17'51.0" 39°29'12.0"
7	06°40'43.9" 35°07'33.1"	08°31'25.2" 35°01'01.4"	16°44'28" 43°59'34"	14°09'98.0" 47°49'87.8"	07°17'54.5" 39°29'16.0"
8	06°40'51.9" 35°07'25.6"	08°31'20.9" 35°01'02.3"	16°44'26" 43°59'34"	14°10'09.7" 47°49'88.8"	07°17'57.8" 39°29'19.0"
9	06°41'00.2" 35°07'19.8"	08°31'18.6" 35°01'01.5"	16°44'20" 43°59'31"	14°10'34.0" 47°49'92.6"	07°17'58.7" 39°29'21.0"
10	06°41'10.8" 35°07'16.7"	08°31'19.7" 35°01'04.1"	16°44'15" 43°59'26"	14°10'22.5" 47°49'94.5"	07°18'19.1" 39°29'44.0"
11	06°41'07.1" 35°07'07.6"	08°31'19.7" 35°01'06.7"	16°44'13" 43°59'25"	14°10'39.7" 47°49'89.0"	07°18'18.1" 39°29'46.0"
12	06°41'12.6" 35°06'55.8"	08°31'16.9" 35°01'08.2"	16°44'03" 43°59'26"	14°10' 41.9" 47°49'84.3"	07°18'19.1" 39°29'50.0"
13	06°42'03.6" 35°07'03.3"	08°31'13.9" 35°01'10.2"	16°44'02" 43°59'26"	14°10'45.2" 47°49'78.3"	07°18'20.2" 39°29'42.0"
14	06°41'59.4" 35°07'04.1"	08°31'10.5" 35°01'14.7"	16°43'52" 43°59'28"	14°10'47.6" 47°49'67.3"	07°18'26.9" 39°29'42.0"
15	06°42'07.1" 35°07'08.1"	08°31'13.5" 35°01'18.3"	16°43'50" 43°59'28"	14°10'47.1" 47°49'63.9"	07°17'20.8" 39°28'32.0"
16	06°42'07.8" 35°07'11.0"	08°31'07.8" 35°01'19.0"	16°43'48" 43°59'30"	14°10'09.2" 47°49'46.8"	07°17'31.8" 39°28'20.0"

continue...

17	06°42’04.7” 35°07’37.1”	08°31’06.8” 35°01’21.0”	16°43’45” 43°59’37”	14°10’00.4” 47°49’25.0”	07°17’36.4” 39°28’16.0”
18	06°42’05.9” 35°07’21.8”	08°31’09.9” 35°01’10.9”	16°43’43” 43°59’40”	14°09’92.2” 47°49’25.9”	07°17’51.3” 39°28’14.0”
19	06°42’24.3” 35°07’05.8”	08°31’18.4” 35°01’17.8”	16°43’41” 43°59’43”	14°09’82.0” 47°49’29.9”	07°16’41.6” 39°31’38.0”
20	06°42’30.2” 35°07’07.3”	08°31’21.0” 35°01’13.9”	16°43’35” 43°59’57”	14°09’65.6” 47°49’36.0”	07°17’22.1” 39°32’22.0”
21	06°42’26.6” 35°07’14.9”	08°31’20.9” 35°01’12.2”	16°43’22” 44°00’05”	14°09’57.9” 47°49’34.4”	07°17’23.3” 39°32’47.0”
22	06°42’26.1” 35°07’21.7”	08°31’23.1” 35°01’16.7”	16°43’26” 44°00’15”	14°09’42.8” 47°49’37.3”	07°17’20.6” 39°32’41.0”
23	06°42’40.7” 35°07’11.8”	08°31’22.3” 35°01’28.1”	16°43’40” 44°00’26”	14°09’23.7” 47°49’31.0”	07°17’20.7” 39°32’15.0”
24	06°42’44.1” 35°07’20.2”	08°31’31.2” 35°01’18.0”	16°43’52” 44°00’39”	14°08’88.9” 47°49’20.0”	07°17’29.1” 39°32’28.0”
25	06°42’52.5” 35°07’11.4”	08°31’32.7” 35°01’16.0”	16°43’56” 44°00’48”	14°09’82.3” 47°49’43.8”	07°17’39.9” 39°32’36.0”
26	06°42’52.1” 35°07’17.8”	08°31’35.7” 35°01’16.9”	16°43’58” 44°00’50”	14°09’94.3” 47°49’47.9”	07°17’31.1” 39°32’29.0”
27	06°44’28.7” 35°08’36.9”	08°31’38.2” 35°01’13.8”	-	14°10’20.9” 47°49’65.5”	-
28	06°44’25.4” 35°08’37.6”	08°31’42.8” 35°01’05.2”	-	-	-
29	06°44’23.2” 35°08’34.9”	08°31’45.8” 35°01’03.0”	-	-	-
30	06°44’22.4” 35°08’31.2”	08°31’44.6” 35°01’02.8”	-	-	-
31	06°44’21.2” 35°08’29.0”	-	-	-	-
32	06°44’21.2” 35°08’27.2”	-	-	-	-
33	06°44’28.0” 35°08’24.0”	-	-	-	-

RGB - Guaribas Biological Reserve; RNSOM – Nossa Senhora do Oiteiro de Maracaípe Private Reserve of the Natural Heritage PELG - Lapa Grande State Park; PNCV - Chapada dos Veadeiros National Park; and FLONA - Araripe-Apodi National Forest.

Table 2. General environmental characteristics of the protected areas, which can influence the genetic variability of mangabeira populations. Data source: http://pt.climate-data.org/

Protected area	Average temperature (ºC)	Altitude above Sea level (m)	Annual average precipitation (mm)	Vegetation type
RBG	25.8	51	1.306	Atlantic Forest
RNSOM	24.8	5	2.144	Restinga
PELG	24.2	661	1.074	Cerrado
PNCV	21.7	1253	1.792	Cerrado
FLONA	25.1	446	1.086	Caatinga/ Cerrado

RGB - Guaribas Biological Reserve; RNSOM – Nossa Senhora do Oiteiro de Maracaípe Private Reserve of the Natural Heritage PELG - Lapa Grande State Park; PNCV - Chapada dos Veadeiros National Park; and FLONA - Araripe-Apodi National Forest.

The population of mangabeira in the *RNSOM* is of low density, and young plants were not observed, indicating that the population is not renewing in the area. Besides, we found many plants with bleeding marks on their stems, which increases the population's vulnerability. According to local informants, the bleeds are made to extract latex to prepare home remedies for treating gastrointestinal disorders. Therefore, although this population is located within a protected area, it is vulnerable to local extinction, based on the evidence of exploitation of tree products and the absence of young plants.

Parque Estadual da Lapa Grande (PELG) – The PELG is located in the Municipality of Montes Claros, in the State of Minas Gerais, and was established by the State Decree nº 44.204.46, in 2006. Its creation aimed to protect caves and conserve their natural wealth. The park is within the Cerrado and covers 7,000 hectares. Before the creation of the protected area, the land was occupied by many farms practising agriculture, livestock farming and wood charcoal production. Currently, the park is administered by the State Forest Institute (IEF) of Minas Gerais, under the responsibility of the Protected Area Coordination (Coordenadoria de Áreas Protegidas do Escritório Regional Norte) in partnership with the Companhia de Saneamento de Minas Gerais (COPASA).

Despite the vast dimension of the park, the population of mangabeira is small and of low density, located on the existent plateau. According to the park administration, fire occurrences are the main threat to this population, and we refer to a massive fire that occurred in 2018. We observed some plants affected by the fire and under regeneration, including some individuals completely burnt exhibiting re-sprouting from the base of the trunk, at the soil level. Along with the high existent biodiversity, the park also protects natural monuments, archaeological, cultural and historic sites, including archaeological and paleontological traces, animal and plant remain and rock paintings dating back to 8 thousand years.

Parque Nacional da Chapada dos Veadeiros (PNCV) – Located between the Municipalities of Alto Paraíso de Goiás, Cavalcante, Teresina de Goiás, Nova Roma and São João d'Aliança in the State of Goiás, the *PNCV* was created in 1961. It covers 240,611 hectares, is administered by the ICMBio and was declared as a world natural heritage by the UNESCO in 2001.

The mangabeira population recorded in the *PNCV* is located near the administration office of the park, between the Alto Paraíso de Goiás and São João d'Aliança Municipalities. However, there are occurrences of plants reported in other park parts, but with lower densities. Regarding the main vulnerability of mangabeira populations, there are imminent risks of fires. For example, there are records of an extensive fire in 2019, reported by national and international news. It was verified that most of the individuals listed in this communication are in areas where there are deactivate mines for gold-panning. Therefore, constant surveillance is required to avoid the installation of illegal mining. Illegal mining activities were recorded in another area of the park during the first semester of 2020.

Floresta Nacional do Araripe-Apodi (FNAA) – The FNAA is located in the Araripe plateau, and covers 38,919.47 hectares, which extend to the Municipalities of Santana do Cariri, Crato, Barbalha and Jardim, in the State of Ceará, administered by the ICMBio. The presence of mangabeira trees was recorded in the transitional vegetation between Atlantic Forest and Caatinga, locally called "Carrasco" (Araújo et al., 1999) in the Municipality of Crato, close to the BR-122 Highway, which crosses the protected area, from Ceará to the State of Pernambuco. The species occur within the dense vegetation but with low population density. However, this is a condition that was not observed in other areas of mangabeira occurrence. Besides, young plants were not observed, which indicates that the population is not regenerating. The low density of mangabeira species is likely due to the high vegetation density. Regarding the vulnerability of mangabeira in the area, we point out the fire as the most critical risk.

Conclusion

The occurrence of mangabeira trees in protected areas in distinct biomes of Brazil constitutes excellent support for the conservation of the genetic resources of this species. Moreover, it guarantees refuge for the genetic resources of the species, including the varieties *pubescens* and *speciosa*. The descriptions of occurrences we report here highlight the significant importance of maintaining protected areas as a suitable strategy for *in situ* conservation. However, to achieve proper conservation, it is fundamental that the protected areas hold the condition for convenient maintenance and management of their spaces and to execute their conservation plans and policies.

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