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Botanical Composition of Fabaceae Family in the Brazilian Northeast, Maranhão, Brazil

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Authors' contributions

This work was carried out in collaboration between all authors. Authors GSG and GSS made the collections, analysis, identification and preparation of botanical material. Author DLSS performed the statistical analysis. Authors RRO and GMC critically reviewed the manuscript, read and approved the final manuscript.

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ABSTRACT

Fabaceae, one of the most diverse families in the world, recognized for its ecological and economic potential; divided into six subfamilies (Caesalpinioideae, Cercidoideae, Detarioideae, Dialioideae, Duparquetioideae) In Brazil, it is the largest botanical family found in all the ecosystems (Amazon and Atlantic Forest, Caatinga, Cerrado, Pantanal and Pampa). The Present investigation identified 22 species, distributed in 14 genera and four subfamilies. *Mimosa* was the most representative genus, with five sorts, followed by *Bauhinia* with three and *Aeschynomene* with two, as to the habit, and 12 species considered shrubs. The composition shown were the floristic list, that help in understanding of plant species present in ecosystems investigated and filling gaps in the Brazilian´s Northeast biodiversity.

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1. INTRODUCTION

Fabaceae is the most diverse plant family in the world [1] with a wide distribution of sort, registering 770 genera and 19,500 sort [2], considered the third largest family of angiosperms in species numbers after Asteraceae and Orchidaceae in the global context [2]. In Brazil, 2848 species are recognized (1539 endemic) and 222 genera [3]. The circumscribed family is in six subfamilies: Caesalpinioideae (146 genera and 4400 species); Cercidoideae (12 genera and 335 species); Detarioideae (84 genera and 760 species); Dialioideae (17 genera and 85 species); Duparquetioideae (1 genus and 1 specie) and Papilionoideae (503 genera and 14000 species) with the inclusion of the groups the previous subfamily Mimosoideae now in the subfamily Caesalpinioideae [2].

The family have economic importance, by having food crops that provide highly nutritious sources of protein and micro nutrients that can benefit health and livelihoods, particularly in the developing countries [4,5] and have ecological attention too because the organism adapted well adapted to the first colonization and exploration of several environments, adaptations caused by their association with nitrogen fixing bacteria or with ectomycorrhizal [6]. The family have association with bacterium of the genus *Rhizobium* located in root nodules found in many species of Fabaceae, converting atmospheric nitrogen into ammonia, a soluble form used by other plants, aftermath in extremely valuable sports as suppliers of natural fertilizers, in addition to their considerable importance in agriculture, representing their ability to occupy different habitats and diverse life forms [7,8,5].

In Brazil, Fabaceae predominates in the ecosystems of Amazon and Atlantic forest, Caatinga, Cerrado, Pantanal e Pampa [7,2]. In the phytogeographic domain Cerrado, the family´s distribution is very broad, being considered a global biodiversity hotspot, accounting for 43% of surface water in Brazil [9]. Currently, global demand for ecosystem recovery has increased significantly in recent years, mainly by integrating ecological restoration to key international policies directly linked to biodiversity [10,11]. The need for conservation and appreciation of tropical grasslands and savannas in the world has been increasing and becoming a cause for concern [12,13,14].

The state of Maranhão presents a huge predominance of Cerrado areas, where knowledge about Fabaceae shows several gaps mainly related to biodiversity records verifying the need for management and conservation of the family species since the Cerrado phytogeographic domain subjects to strong anthropogenic pressures.

The understanding and registration of biodiversity provides support for future research of the most diverse nature, clarifying the doubts the nomenclature atop species with the potential to increase the knowledge of new groups occurrences. Works as this are important obtaining data on the unknown species for the area of study. This can be verified in works such as [15] which recently recorded new occurrences species of Papilionoideae to the Maranhão´s state.

The research objective was to catalog the Fabaceae´s species occurring in the municipality of Coelho Neto/MA, and to elaborate a floristic list, for the subfamilies Caesalpinioideae, Cercidoideae, Detarioideae, Dialioideae, Duparquetioideae and Papilionoideae.

2. MATERIALS AND METHODS

2.1 Characterization of Collection Area

The state of Maranhão has a surface area of 331,983.29 km^2, being the eighth largest Brasilian state and the second Northeast territorial extension. It is located between the parallels 01º01 ’and 10º21’ South and the meridians 41º48 ’and 48º50’ West. The state has five Geographical Mesoregions, subdivided into 21 Geographic Microregions, where its 217 municipalities are inserted [16].

The Eastern Mesoregion State is the Coelho Neto-MA municipality, with an area of 975,543 km² and 46,750 habitants according to the last census. Coelho Neto sited 361 km from the capital São Luís, Maranhão (Fig. 1). The Municipality established by Law 764, dated December 22, 1934 [17]. With Cerrado phytogeographic domain type, representing a huge vegetation covering, the Coelho Neto municipality, together with other municipalities,

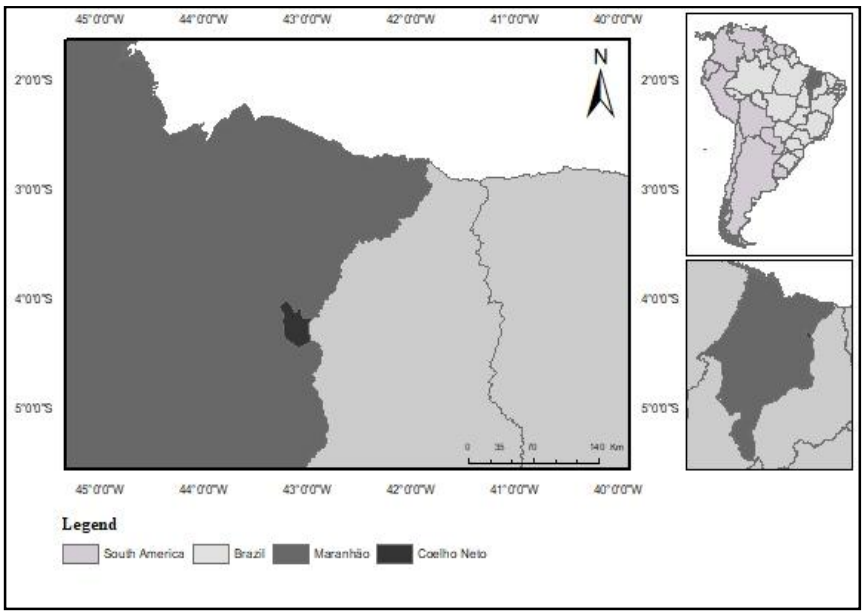

Fig. 1. Coelho Neto´s Map, Maranhão/Brazil, collection area of Fabaceae´s species

have the Morros dos Garapenses´ Environmental Protection Area, with 234,768 ha, created by Decree No. 25.087 of December 31 of 2008 [18].

2.2 Survey and Treatment of Botanical Material

The floristic survey comprised three stages: fieldwork, analysis and identification and preparation of botanical material. Monthly expeditions, enduring two or three days carried out in September 2016 to June 2017, to observe, collect and identify the botanical material in Coelho Neto´s/MA municipality. The botanical material was collected with pruning shears at reproductive stage and five samples of each specimen were bagged, following the standard methodology [19]. For each specimen collected, annotations were made, such as: date and place of collection (locality, municipality, state and geographic coordinates), name of collector, and physical characteristics of the environment (such as slope, soil type, watercourses, etc.).

The following traits noted for each plant collection: plant life habit, height, the bark characteristic, color and leaves textures, flowers and fruits and other striking features that will aid in species identification. In the botanical herborization process, the plant specimens, pressed between newspaper sheets, cardboard and dried at ambient environmental temperature. With the dehydrated material, fixed in paperboard, of appropriate size (28 x 42 cm), where they received labels with informative data, constituting the exsiccate.

The specimens collected and identified by comparison with the material, specialized bibliographies [20,7,21,22,33], books, virtual herbarium and taxonomic keys following the recommended classification methodologies [24,2] and sending samples to specialists in the group for reconfirmation of identification. Proceeding with the species identification, exsiccate assembly, all allocated at Herbarium Prof. Aluízio Bittencourt (HABIT), together, with other Fabaceae family exicts, contained in the herbarium, where all identification and field data stored in exsiccate information sheets, organizing and updating the collection. Taxon nomenclature data, author, main work obtained [25], geographic distribution and phytogeographic species domains according to FLORA DO BRASIL digital platform under construction 2020. Richness, abundance, and genus sampling, species, life habit and analyzed the physiognomy survey.

2.3 Rarefaction Test

Drawn up an interpolation and extrapolation rarefaction curve, stem from the datas of gathering analyzed. Rarefaction curve, as know as interpolation, has the pupose to estimate which could have been the strengths of species

of a community, if the sample effort could have being narrow to an specific amount [26]. The analyses held with the support from the software R 3.2.0 with the package iNEXT (R Development Core Team, 2015) and confidence interval of trust from 95%.

3. RESULTS AND DISCUSSION

The 41 specimens we sampled representing 14 genera and 22 species of Fabaceae found in the Municipality of Coelho Neto. Fabaceae belongs to families among angiosperms that has the greatest species richness in the different phytogeographic Brazil domains [28]. The species representation and genera Fabaceae subfamilies sampled in this research indicate that of the 41 specimens studied, nine belong to the subfamily Caesalpinioideae distributed in five genera, eight species and seven genera belong to Papilionoideae, one genus and four species of the subfamily Cercidoideae and one species of Detarioideae (Table 1). The highest species richness belongs to Caesalpinioideae, which has Pantropical distribution with wide morphological and reproductive variability [29].

The diversity of genera, Papilionoideae was the most represented subfamily with seven genera which showing a broad geographic distribution [2]. Regarding the genera under study, *Mimosa* was the most represented genus with five species, followed by *Bauhinia* with three species and *Aeschynomene* with two species. (Fig. 2).

Mimosa L. comprises 540 species, being the second largest genus of the mimosoid clade [30,2], distributed mainly in the Neotropical region, with approximately 496 taxa of the Neotropics and 40 native species of the old world [29,31]. The genus *Bauhinia* L. has Pantropical distribution, and approximately 160 species [32]. Among the 17 genera included the Dalbergieae tribe, *Aeschynomene* stands out for its large morphological-vegetative variation and floral morphology, which makes promising to phylogenetic and taxonomic studies. This genus has a Pantropical distribution, comprising about 180 species [7], 84 of which occur in the Americas [33].

Regarding life habit of the studied species, observed that the habit of the herb type presented three individuals, subsequently the habit of the tree type with 6 and shrub with 13. Observed the existence a greater representation with a sort “shrub”, as shown in (Fig. 3). Sorts with shrub types predominated in the area, representing 12 species. However, other habits of life such as herbs and trees were observed, as found in Fabaceae works for Maranhão [34,35,36].

The habit of the family is variable, from trees, shrubs, subshrubs to upright herbs, creeping or even climbing [28]. This habit of shrubs is characterized by woody structures varying size, but not exceeding 6 m in height, and stem with branches very close to the ground [37]. The shrubs are comprised of woody plants, in which the support and stem tissues form layers that are added year after year [19].

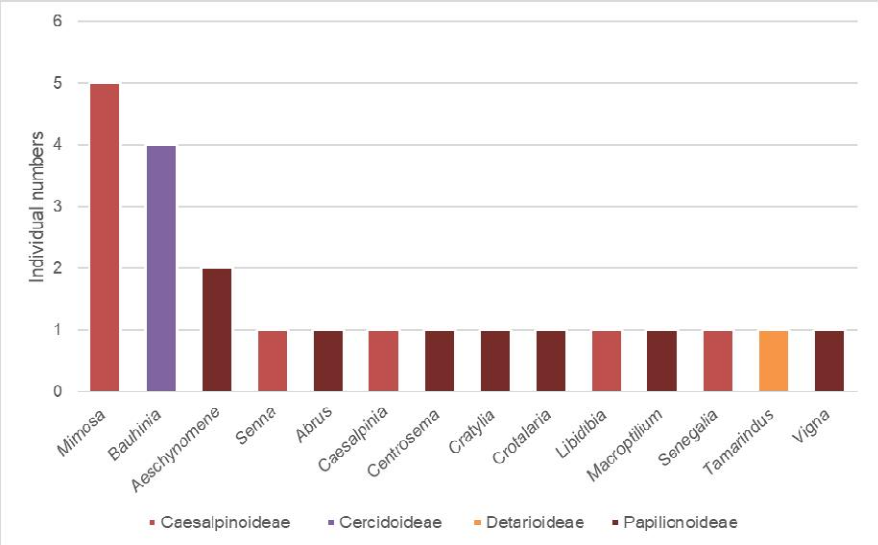

Fig. 2. Number of species sampled for each genus of Fabaceae

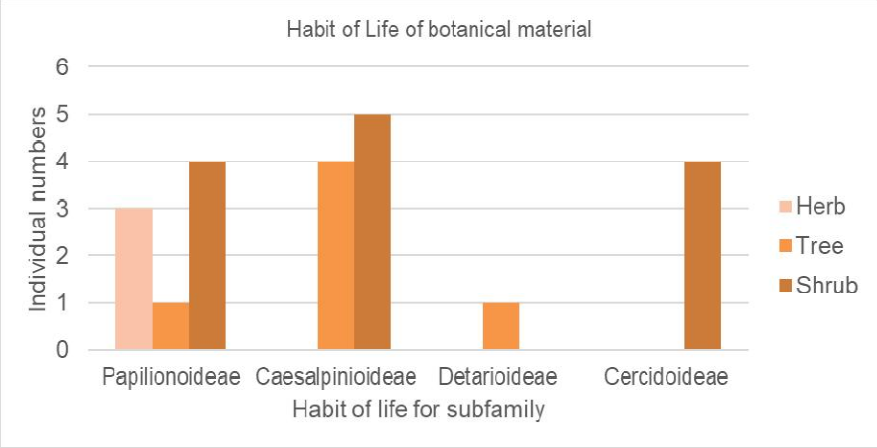

Fig. 3. Representation of habit of life of the species studied

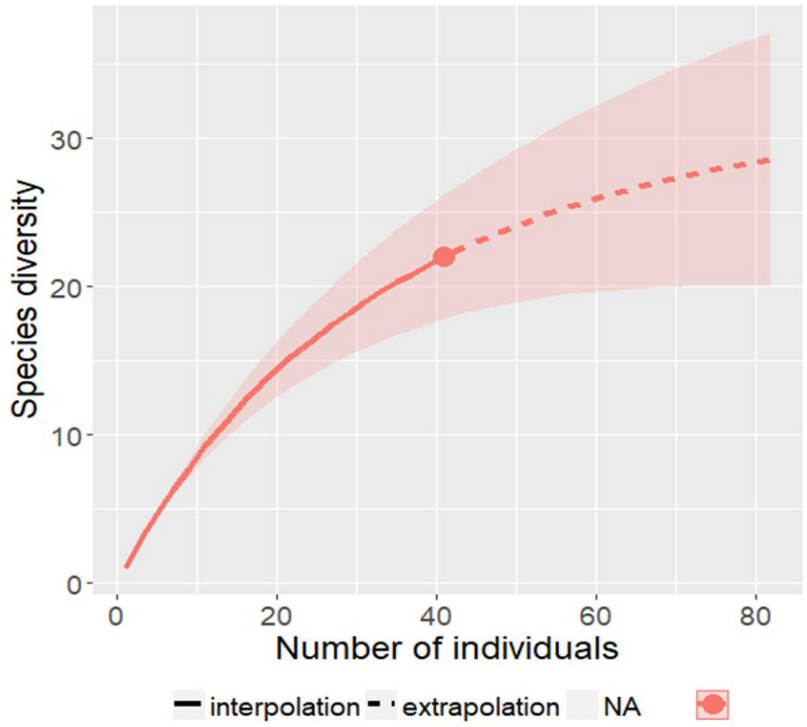

Fig. 4. Interpolation and extrapolation rarefaction curve from the data collection, with confidence interval (95%)

As for the environment where the species collected, all species found in the gallery forest physiognomy. Among the vegetal formations of the Cerrado, the Mata de galeria, as known as Mata ripária or Mata ciliar by some researchers, characterized by associated to water courses, and this formation, although small, possesses richness, genetic diversity and acts in the protection of water resources [38].

As shown in the interpolation and extrapolation rarefaction curve (Fig. 4), the amount of species in order to range study area is much higher, when compared to with the shown number. Documented 22 species, spread between 41 individuals in four subfamilies (Table 2), with the rarefaction curve estimate 31 species ranged and 80 individuals.

Table 1. List of species of Fabaceae of the municipality of Coelho Neto/MA, distributed in their respective subfamilies

Nº	Subfamily	Specie	Brazilian geographic distribution	Phytogeographic domain
1.	**Caesalpinioideae**	*Caesalpinia pulcherrima* (L.) Sw.	AC, AM, AP, PA, RO, RR, TO, AL, BA, MA, PE, PI, RN, SE, DF, GO, MS, MT, ES, MG, RJ, SP, PR, RS, SC.	Amazon forest, Cerrado e Atlantic forest.
2.		*Libidibia ferrea* (Mart. Ex Tul.) L.P Queiroz	AL, BA, CE, MA, PB, PE, PI, RN, SE, ES, MG, RJ.	Caatinga, Cerrado e Atlantic forest.
3.		*Mimosa candollei* R. Grether	AC, AM, AP, PA, RO, RR, TO, AL, BA, CE, MA, PB, PE, PI, RN, SE, DF, GO, MS, MT, ES, MG, RJ, SP, PR, SC.	Amazon forest, Caatinga, Cerrado e Atlantic forest.
4.		*Mimosa pigra* L.	AC, AM, AP, PA, RO, RR, TO, AL, BA, CE, MA, PB, PE, PI, RN, SE, DF, GO, MS, MT, ES, MG, RJ, SP, PR, SC.	Amazon forest, Caatinga, Cerrado, Atlantic forest e Pantanal.
5.		*Mimosa sensitiva* L.	AM, PA, RO, TO, AL, BA, CE, MA, PE, PI, RN, SE, DF, MS, MT, ES, MG, RJ, SP.	Amazon forest, Caatinga, Cerrado e Atlantic forest.
6.		*Mimosa acutistipula* (Mart.) Benth.	PA, BA, CE, MA, PE, PI, DF, GO, MS, MT, RJ.	Amazon forest, Caatinga, Cerrado e Atlantic forest.
7.		*Mimosa xanthocentra* Mart.	PA, RO, TO, BA, CE, MA, PI, DF, GO, MS, MT, MG, RJ, SP, PR, SC.	Amazon forest, Cerrado e Atlantic forest.
8.		*Senegalia polyphylla* (DC.) Britton	AM, PA, AL, BA, CE, MA, PB, PI, SE, DF, GO, MS, MT, ES, MG, RJ, SP, PR.	Amazon forest, Caatinga, Cerrado, Atlantic forest e Pantanal.
9.		*Senna velutina* (Vogel) H.S. Irwin & Barneby	TO, BA, CE, MA, PI, DF, GO, MS, MT, MG, SP.	Amazon forest, Caatinga e Cerrado.
10.	**Cercidoideae**	*Bauhinia forficata* Link	AL, BA, MA, PE, ES, MG, RJ, SP, PR, RS, SC.	Atlantic forest e Cerrado
11.		*Bauhinia cupulata* Benth.	PA, TO, BA, MA, PI, GO, MT.	Amazon forest, Caatinga e Cerrado.
12.		*Bauhinia dubia* G. Don.	AM, PA, TO, CE, MA, PI.	Amazon forest e Cerrado.
13.		*Bauhinia ungulata* L.	AC, AM, AP, PA, RO, RR, TO, BA, CE, MA, PI, DF, GO, MS, MT, MG, RJ, SP.	Amazon forest, Cerrado e Atlantic forest.

Nº	Subfamily	Specie	Brazilian geographic distribution	Phytogeographic domain
14.	**Detarioideae**	*Tamarindus indica* L.	AC, AM, AP, PA, RO, RR, TO, AL, BA, CE, MA, PB, PE, PI, RN, SE, DF, GO, MS, MT, ES, MG, RJ, SP, PR, RS, SC.	Amazon forest, Caatinga, Cerrado e Atlantic forest.
15.		*Abrus fruticulosus* Wight & Arn.	AM, AP, PR, RR, AL, BA, CE, MA, PB, PE, PI, RN, SE, DF, GO, MS, MT, ES, MG, RJ, SP, PR, SC.	Amazon forest e Cerrado.
16.	**Papilionoideae**	*Aeschynomene brasiliana* (Poir.) DC.	AM, AP, PA, RO, RR, TO, AL, BA, CE, MA, PB, PE, PI, DF, GO, MS, MT, ES, MG, RJ, SP, PR.	Amazon forest, Caatinga, Cerrado, Atlantic forest e Pantanal.
17.		*Aeschynomene Rudis* Benth.	AM, AP, PA, AL, BA, CE, MA, PB, PE, PI, RN, MS, ES, MG, SP, PR, RS, SC.	Amazon forest, Caatinga, Cerrado, Atlantic forest, Pampa e Pantanal.
18.		*Centrosema brasiliana* (L.) Benth.	AM, AP, PA, RR, AL, BA, CE, MA, PB, PE, PI, RN, SE.	Amazon forest, Caatinga, Cerrado, Atlantic forest e Pantanal.
19.		*Cratylia argentea* (Desv.) Kuntze	AC, PA, RO, TO CE, MA, PI, DF, GO, MT, MG.	Amazon forest, Caatinga e Cerrado
20.		*Crotalaria retusa* L.	PA, BA, MA, PI, MG, RJ, SP, PR, RS, SC.	Amazon forest, Caatinga, Cerrado, Atlantic forest e Pampa.
21.		*Macroptilium lathyroides* (L.) Urb.	AM, PA, RR, AL, BA, CE, MA, PB, PE, PI, DF, GO, MS, MT, ES, MG, RJ, SP, PR.	Amazon forest, Cerrado, Atlantic forest e Pantanal.
22.		*Vigna unguiculata* (L.) Walp.	RN, MS, MT, MA, MG, RJ, SP, PR,	Amazon forest, Cerrado e Atlantic forest.

Meanings of the acronyms of brazilian geographical distribution: Acre-AC; Alagoas–AL; Amapá–AP; Amazonas–AM; Bahia–BA; Ceará–CE; Distrito Federal–DF; Espírito Santo–ES; Goiás–GO; Maranhão–MA; Mato Grosso–MT; Mato Grosso do Sul–MS; Minas Gerais–MG; Pará–PA; Paraíba–PB; Paraná–PR; Pernambuco–PE; Piauí–PI; Rio de Janeiro–RJ; Rio Grande do Norte–RN; Rio Grande do Sul–RS; Rondônia–RO; Roraima–RR; Santa Catarina–SC; São Paulo–SP; Sergipe–SE;Tocantins–TO

Table 2. Distribution of species number (S / N), number of individuals (N / I) and number of genera (N / G) in relation to Fabaceae subfamilies found in the study area, Maranhão / Brazil

Subfamíly	S/N	N/I	N/G
Caesalpinioideae	9 (40,9%)	17(41,5%)	5 (35,8%)
Cercidoideae	4 (18,2%)	9 (22%)	1 (7,1%)
Detarioideae	1 (4,5%)	1 (2,4%)	1(7,1%)
Papilionoideae	8 (36,4%)	14 (34,1%)	7 (50%)
Total	22	41	14

The floristic studies, look up to know many species as possible, albeit the bind in the sampling [39]. The specimen research was meaningful to put forward thereabouts 71% of the species and 51,2% of the individuals of the extrapolated sample. The rarefaction curve shows the advantage to lay down a confidence interval with differences statistically significant between the curve and their [40].

Despite the high estimation Fabaceae species in Brazilian Northeast, the family is still sub-sampled, considering areas not collected, including Maranhão, which requires specific floristic surveys of diversity to fill gaps and uncertainties of plant occurrence information a central problem in ecology and conservation has been demonstrated [41].

4. CONCLUSION

The study area presented 14 genera, distributed in 22 family Fabaceae species, sampled in four subfamilies. Papilionoideae with higher taxon richness, predominating shrub species, are characteristic of the Cerrado ecosystem.

The species composition area for the Cerrado helps understand the floristic formation of these ecosystems, helping to fill gaps in the Brazil biodiversity and the world, despite the various anthropic evidences for the study area that put the vegetal Cerrado´s species in threat of extinction. The results will serve as basis for the elaboration management plans for species conservation, helping to computerize the conservation status of each group, directed to the preservation of environments and species of Fabaceae.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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