QUALI-QUANTITATIVE EVIDENCES OF PLANT BLINDNESS ON PASSERSBY OF AN URBAN GREEN SPACE WITH PLAQUED TREES

EVIDÊNCIAS QUALI-QUANTITATIVAS DE CEGUEIRA BOTÂNICA EM TRANSEUNTES DE UMA ÁREA VERDE COM ÁRVORES PLAQUEADAS

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Abstract

Plant blindness is a common phenomenon in urban green spaces. As an element of biodiversity perception, it is socially and individually determined. This work reveals evidences of plant blindness through a quali-quantitative survey of 49 interviews in an urban green area of the city of São Paulo, Brazil, chosen as spot for the installation of informative plaques in many notable trees. Respondents were not able to properly identify plant elements and they undervalued the richness of different types of plants. Albeit pointing out the importance of green spaces on improving quality of life, respondents underestimated the importance of maintaining not only a whole green space, but also a biodiverse one. We discuss that the perception of a "good" green space is less associated with species richness and more with passersby expectations of a green area and with an innate plant blindness phenomenon. We believe that informative plaques may play a role to reduce plant blindness, since they individualize plants that were once seen as components of a monotonous green landscape.

Keywords: Environmental perception. Plant biodiversity. Parks and squares. São Paulo.

Resumo

A cegueira botânica é um fenômeno recorrente em áreas urbanas. Sendo um componente da percepção da biodiversidade, ela é socialmente e individualmente construída. Este trabalho traz evidências de cegueira botânica através de uma análise quali-quantitativa de 49 entrevistas em uma área verde na cidade de São Paulo escolhida para a instalação de placas informativas em várias árvores notáveis. Os entrevistados não foram capazes de identificar corretamente elementos vegetais e subestimaram a riqueza de tipos diferentes de plantas. Apesar de eles terem destacado a importância das áreas verdes na melhoria da qualidade de vida, os entrevistados minimizaram a importância de se manter espaços verdes íntegros, bem como a necessidade de que esses sejam biodiversos. Discutimos que a percepção do que é uma "boa" área verde está menos associada com a riqueza de espécies, e mais com as expectativas criadas ao se visitar uma área verde, sendo ainda influenciada pela cegueira botânica inata. Acreditamos que as placas informativas podem ter um papel relevante na redução da cegueira botânica, já que elas individualizam plantas que antes eram vistas apenas como componentes monótonos de uma paisagem verde.

Palavras-chave: Percepção ambiental. Biodiversidade vegetal. Praças e parques. São Paulo.

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1. Introduction

Environmental perception is associated to the apprehension of different natural elements, as well as of ecological interactions and their potential consequences in a particular environment (BOGNER; WISEMAN, 1999; GOBSTER, 2007). As these events do not only include individual conceptions but also actions and values that are socially shared (STERLING, 2009), environmental perception is also a social rather than only an individually determined phenomenon. Consequently, environmental education has become an important tool towards the maintenance of a sustainable nature-society relationship, especially in urban areas (ITTELSON, 1978; LEFTRIDGE; JAMES, 1980; VOIGT; WURSTER, 2015).

Plant elements can influence environmental perception as well, as different landscapes elicit several unique cognitive perceptions. Particularly in urban green spaces, plant biodiversity perception is much more tied to the perception of the concept of "biodiversity" itself than of the landscape (WANDERSEE; SCHUSSLER, 1999; 2001). For plants, Wandersee & Schussler (2001) defined a very interesting concept called "plant blindness", i.e., when people undervalue or are somehow unable to properly recognize plant elements, as well as their importance in daily life (HERSHEY, 2002; WANDERSEE; SCHUSSLER, 2001). In other words, the identity of plant elements is often underestimated and left aside when biodiversity is the main matter of a discussion. Few are the examples in which plant elements are positively highlighted; most times, they are taken into account only in negative scenarios, such as when the issue is associated to plant biodiversity loss rather than when exalting or reaffirming its identity as an important component of a landscape (VIANA *et al., 2014*; VOIGHT; WURSTER, 2015).

Although individuals may perceive the environment differently, some initiatives have been taken in several urban green spaces towards diminishing plant blindness – even when considering no prior planning beforehand (GOBSTER, 2007). Tree plaquing is one of such initiatives, and it is justified on the fact that knowledge about plants can alter people's relationship with nature, thus enhancing sustainable actions (PANAGOPOULOS; DUQUE; DAN, 2016; SALATINO; BUCKERIDGE, 2016). Conversely, tree plaquing may not be such a straight-forward initiative, as plaques can also be responsible for a sort of "museumification" of green spaces (GOBSTER, 2007). Either way, identifying trees through informative plaques is a common strategy applied in urban green spaces, and there is a lack of knowledge on how they can impact environmental perception.

In summary, few works attempted to properly assess a clear relation between collaborative initiatives – such as tree plaquing – and biodiversity perception. Furthermore, quantitative evidences of plant blindness are scarce in the literature. That said, the aim of this work is to discuss environmental perception associated to plant biodiversity in urban spaces – where the prevalence of plant blindness seems to be high. We aim to bring new insights on how the implementation of informative plaques can influence environmental – positively and negatively – and biodiversity perception, taking an urban green space in a university campus in São Paulo as a study case. Specifically, we would like to address the following questions: (i) How do passersby of a selected urban green space recognize plant biodiversity? (ii) How the plant biodiversity perception is associated to conceptions of a "good" green space? (iii) How does the tree plaquing impact landscape or plant perception? We advocate such survey will bring new subsids to public initiatives of maintaining urban green areas, as well as novel research and conservation initiatives of nature spaces and the diminishment of plant blindness.

2. Material and Methods

2.1. Description of the study area and research context

Albeit being a huge urban center today, the city of São Paulo still bears a significative amount of remnant vegetation,

as well as of areas with a proper urban arborization plan (SMA, 1988). Nevertheless, plant cover is not homogeneously distributed through the city, and particular spots of São Paulo are more or less wooded than others (TAKIYA, 2002). São Paulo's heterogeneous plant cover is consequence of a historical and intense occupation process that took place especially from the 19th century, with the expansion of coffee crops and migratory events of the 20th century (TAKIYA, 2002). Such disorderly city growth resulted in a peripheralization event, where several edged areas of the urban network were occupied without any prior planning (TAKIYA, 2002).

The study area of our survey is located in a well-wooded planned area of the western zone of the city of São Paulo. It is a green space in the "Instituto de Matemática e Estatística" (Institute of Mathematics and Statistics; henceforward, "IME green space"), at one of the campus of the University of São Paulo in Brazil (Figure 1). Following the global panorama of urban planning of university green areas (see SPEAKE *et al.*, 2013), the "Cidade Universitária Armando de Salles Oliveira" bears important green areas, as well as a significative remnant of the Brazilian Atlantic Forest (MENDONÇA, 2004; ROSSI, 1994). Specifically, IME green space is also a major access point among other spots of the university (Figure 1) and, due to so, its green area is mainly frequented by passersby whose final destination are not the IME green area itself. Therefore, IME green space is always taken as a access path and less enjoyed for leisure, culture and sport purposes. Still, IME green space is a rather busy area, especially during specific workday hours.

Our research dates to 2015, when the Pro-Rectory of Culture and Extension of the University of São Paulo, in partnership with students of the Institute of Biosciences of the same university, lead off a project entitled "Árvores USP" ("USP Trees"; check http://www.ib.usp.br/botanica/arvores-usp, page in Portuguese). We have followed and participated of the whole processes from choosing and selecting plants to be plaqued, until the final plaques installation in 2017. One of the main goals of this initiative was to install informative plaques in selected trees of particular green spaces of the university. Figure 2 shows an example of a plaque model of the project.

IME green space also has a historical importance since the 70s, when several saplings of native and exotic species were planted by IME students, as an initiative of a professor at the time (LOPES, 2017). Although tree planting did not follow a specific plantation framework, all trees compose today an important portion of the local cultivated flora and of the gardened areas of the institute. More than 40 years later, between 2015 and 2017, the "Árvores USP" project contacted IME staff team and they selected ca. 30 "remarkable trees" in different spots of the institute's main gardened area that would later receive most of the informative plaques. The term "remarkable tree" or "remarkable plant" is a concept arbitrarily created by the "Árvores USP" project when selecting which trees to plaque. It refers to any arborescent plant (i.e. including trees and palms) located in an accessible spot of the green area – therefore near any path, track or cemented region – and that could easily be noticed in the green landscape of the urban green space – thus, not growing too much close to other trees that would difficult the individualization of the plant, otherwise hampering its observation.

2.2. Data gathering and analysis

This paper is based on a quali-quantitative approach and is characterized as a quali-quantitative study, described by Flick (2009). We conducted a total amount of 49 interviews in two different moments of 2017: one moment before plaques installation, between March the 10th to the 20th (N = 28 interviews) and other on May 16th (N = 21 more interviews), approximately 30 days after plaques have been installed. Due to the particular location of IME green space – within an institute that connects different spots of the surrounding areas of the *campus* – it was not that straight-forward to find novel respondents after a while, and most of them were not familiarized with the green space. Nevertheless, we believe this sampling effort represents a fair portion of individuals that pass by the IME green space in a day.

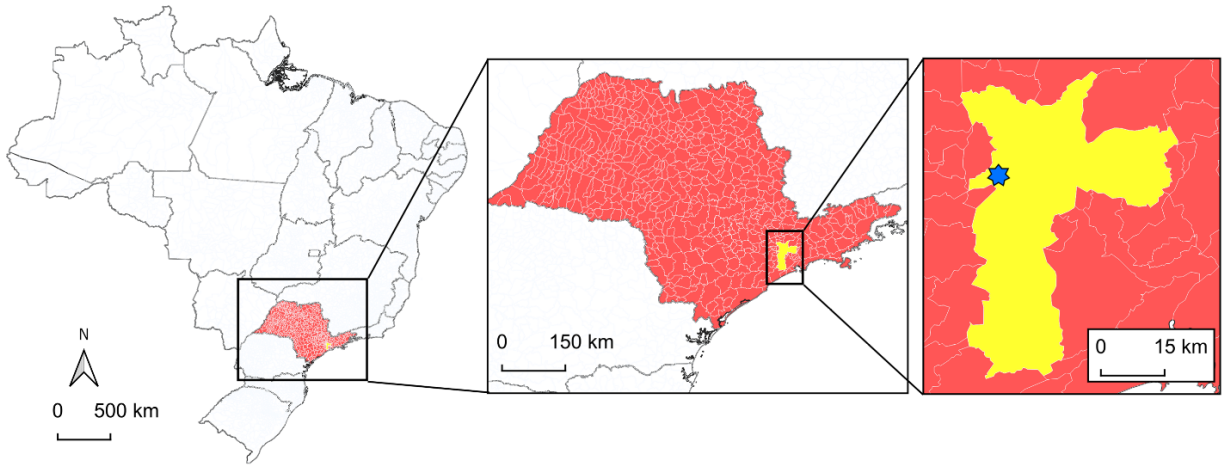

Figure 1. Location of IME green space in Brazil and São Paulo state (blue symbol indicates its location on minor scale). We also provide photos of several perspectives of the green area (items a-e) showing the main panorama of the vegetation and the local flora at the time.
Source: Matheus Colli-Silva

Figure 2. Sample layout of an original plaque installed on IME green space in Portuguese. Plaques were made of stainless steel, measuring 20x15 cm and were fixed on a cement support around 30 cm tall. Information contain: Scientific name ("Nome científico"), Botanical family ("Família botânica"), Origin ("Origem"), and More Information ("Mais informações"). Below those items, it is presented a short description of the species, as well as their medicinal, edible or toxicity properties, if applicable. Photo provided by Árvores USP team.

Regarding the approach of respondents, we accompanied the movement of the space in a day, randomly approaching passersby and inviting them to collaborate with our survey after informing the main purpose of it. If they agreed to participate, we then proceeded to the interview application, and, at the end of the interview, respondents should sign a free and informed consent form, keeping a copy of it with them.

Interviews followed a semi-structured script (available in Appendix 1 in Supporting Information), according to Lankshear and Knobel (2008). Essentially, our script included questions about (a) general information about the respondents and its frequency of visit in the IME green space; (b) conceptions about what a "good" green space should be; (c) comparisons and recognitions of different types of plants, when in the landscape and when individualized in a photo. Questions that mentioned technical terminologies, such as "green area" or "types of plants" were not previously clarified by us, so the respondents could answer according to their previous knowledge about such concepts.

To answer questions (i) and (ii) of this work, regarding the perception of the surrounding vegetation and of the green spaces as a whole, we asked respondents to estimate how many "different types of plants" they could distinguish in space. Thus, respondents should take a panoramic view over the surrounding landscape and tried to estimate how many different plant types (or, in other words, discrete species) they could properly distinguish. We preferred to use the term "types of plants"

rather than "species" or "specific taxa", to avoid potential misunderstandings on defining concepts which, although being intuitive in some cases, are not trivial even for the academic community (check Queiroz (2007) for some further discussion on that issue). Anyhow, in our survey, we ended up noticing that respondents frequently associated "types of plants" to their own concept of "species", treating those as synonyms.

In addition to asking to estimate the number of discrete types of plants occurring in the IME green space, we also required respondents' view about green spaces, their importance, and which elements a green space should hold to be considered as what they would conceive as a "good" one. We asked that because we presume the perception of a green space might influence positively on biodiversity perception, so we wished to check that out.

Alternatively, we previously took some photographs of selected species that occurs in the IME green space to measure respondents' skills of plant identification or at least recognition. For this, we developed photos (dimensions of 29.7 x 42 cm) of specimens of six species which occur in different areas of IME green space (Figure 3). Most of the photos, except for the cycad (Figure 3D) are from plants that received informative plaques afterwards.

All interviews were conducted in the IME green space, where respondents were able to critically evaluate the landscape and distinguish dozens of remarkable trees, as well as those presented in the photos. We chose to show six species (or six different types of plants) to respondents, so they could recognize a certain diversity of plant lifeforms (i.e. trees with woody trunks, palm trees and cycads). Besides, we chose to mix photos of species native to Brazilian Atlantic Forest (*Libidibia ferrea* (Mart. ex Tul.) L.P. Queiroz (Leguminosae), Figure 3B and *Euterpe edulis* Mart. (Arecaceae), Figure 3F) with exotic ones (*Terminalia catappa* L. (Combretaceae), Figure 3A; *Bauhinia variegata* L. (Leguminosae), Figure 3C; *Cycas revoluta* Thunb. (Cycadaceae), Figure 3D; *Dypsis lutescens* (H. Wendl.) Beentje & J. Dransf. (Arecaceae), Figure 3E). Thus, for each lifeform, we selected two photos of different species, so they could be compared between.

Lastly, to answer question (iii) of this work, regarding the implementation of informative plaques, we performed two different approaches in the two moments in which the interview was applied. For the first group of respondents, i.e., those interviewed before plaque installation, we asked, at the end of the interview, if tree plaquing in IME green space would be an interesting initiative. For the second group, i.e., those interviewed right after tree plaquing, we asked if they noticed the plaques in the IME green space and we asked their view about such initiative.

All interviews were recorded and further transcribed after the authorization of the respondents. Data for closed questions were quantified, and open questions were analyzed through a Content Analysis framework (BARDIN, 1997), with creation of *a posteriori* categories and definition of units of record. To assess and quantify biodiversity perception and to assess statistical differences between different sets (i.e., respondents before vs. after tree plaquing; or respondents who think IME green space is rich/biodiverse in different types of plants vs. those who do not think so), we performed standard descriptive statistical analyses as well, namely a Mann-Whitney non-parametric test. Under that test, we assessed if (1) respondents' performance were different with gender, age and place of birth; if (2) plant perception were different comparing responses before and after tree plaquing; and finally if (3) respondents who declared IME green space is rich, diverse in different types of plants made a better estimation of number of types occurring in IME landscape than those who not declared that.

3. Results

3.1. Respondents profile

All respondents had, in average, 26.5 years old, although most of them had between 17 and 25 years. Interestingly, the majority were men (81%) and all were somehow enrolled to the university, whether as an undergraduate or graduate student, functionary

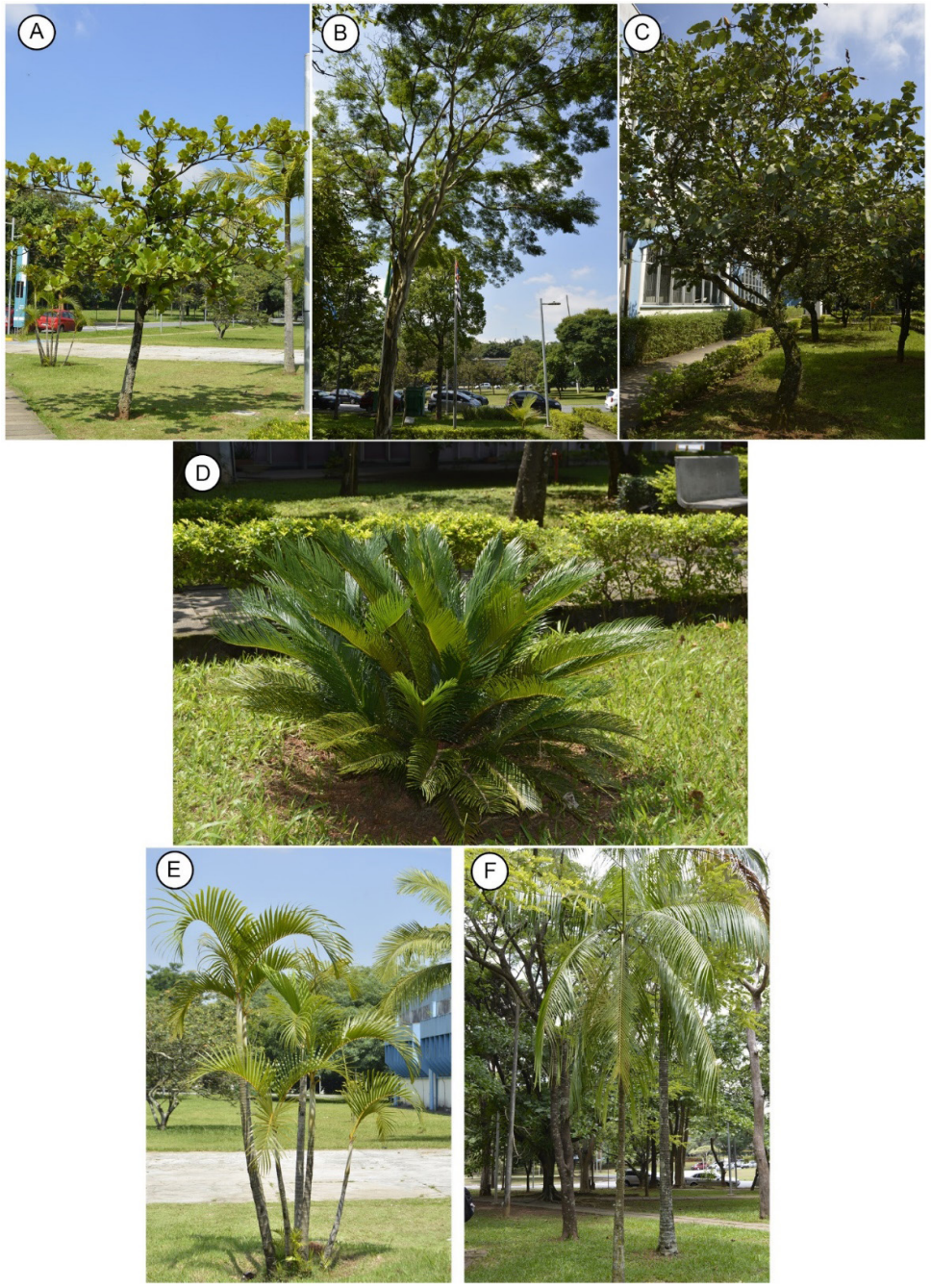

Figure 3. Photos of selected species shown in interview. (A) "chapéu-de-sol", *Terminalia catappa* L. (Combretaceae) non-native to Brazil; (B) "pau-ferro", *Libidibia ferrea* (Mart. ex Tul.) L.P. Queiroz (Leguminosae), native to Brazilian Atlantic Forest; (C) "pata-de-vaca", *Bauhinia variegata* L. (Leguminosae), non-native to Brazil; (D) "cica" *Cycas revoluta* Thunb. (Cycadaceae), non-native to Brazil; (E) "areca-bambu", *Dypsis lutescens* (H. Wendl.) Beentje & J. Dransf. (Arecaceae), non-native to Brazil; (F) "palmito-juçara", *Euterpe edulis* Mart. (Arecaceae), native to Brazilian Atlantic Forest.
Source: A, B, C. Gisele Gomes Nogueira Alves. D. Lui Agostinho Teixeira. E, F. Daniela Gomes Almeida-Costa.

or professor. Most were IME students; two respondents were functionaries (one of them from IME) and three were professors. Gender bias might be related to the fact that most students of IME are men (according to official documents of the University); thus, it is expected that our sampling was mainly composed of men respondents.

Most respondents said to frequent IME green space weekly (88%, 43 individuals), 81% of those (35 individuals) visiting IME green space daily. All respondents declared having at least some familiarity with an urban landscape, which is expected, considering the majority were born and/or raised in big cities, mostly in the Metropolitan Region of São Paulo state. 82% of respondents (40 individuals) declared to have lived in a city for at least a year, and 83% of those (33 out of the 40) were born in a city of the Metropolitan Region. There were some outlier cases where people were from other Brazilian urban centers (Salvador and Curitiba, in the states of Bahia and Paraná, respectively) or even from other countries (more specifically to Chile, Bolivia, Peru, Russia and France), but these also declared to be born or raised mostly in an urban context.

3.2. Conception of green space and estimating richness of plant elements

Most respondents agreed that IME green space was rich and biodiverse in terms of composition of different types of plants. Approximately 60% of all mentions (or 45 out of a total amount of 79 mentions) shared such conclusion, and their justifications were mostly based on observations of the space and its characteristics (Table 1). However, references to plant diversity were more often related to the concept of abundance (i.e. presence of a great number of plant specimens), usually neglecting the concept of taxa richness as a component of biodiversity.

In other words, most respondents agreed that, for a green space to be considered as a "good" one, it should have a relatively

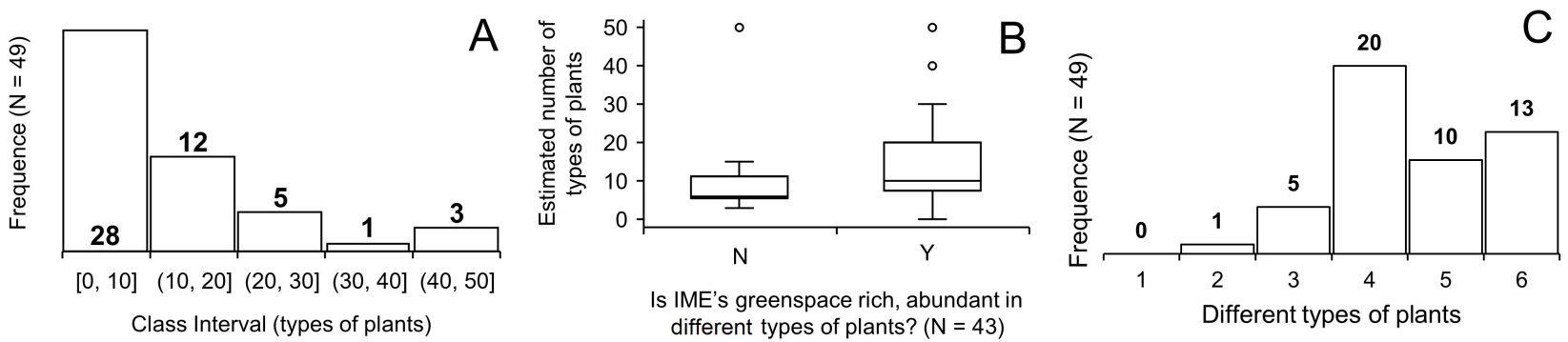

Figure 4. Standard descriptive analyses of our results. (A) Histogram of different types of plants occurring in IME green space, estimated by almost all respondents (N = 43, not considering those who did not answer). (B) Boxplots relating plant diversity in IME green space, i.e., the number of types of plants estimated to occur in area versus the fact of considering IME green area as a rich, abundant or diverse. Mann-Whitney test for 43/49 respondents reveals statistical difference between those who consider IME as a good green space and those who not (Z = 2.099, p-value = 0.036, at 0.05 significance level). N = 43 because we did not consider those who declared not able to estimate the number of plants. (C) Histogram summarizing the amount of different types of plants discriminated by respondents, based on the six photos we have shown.

Table 1. Content analysis referent to IME green space being rich, diverse in different types of plants.

Do you consider this greenspace as rich, abundant in different types of plants?					
Category	**Description of answer**	**Units of record**	**Example of answer [loose translation to English]**	**Number of mentions**	**Total**
Yes	Answer based on observation of space and plant characteristics.	[plants] visually different; different trunks; different life forms.	"(...) There are several types of trees, I don't know exactly which ones, but it seems there are several types (...). There are some flowers here, on the other side there is an area nobody treads, it seems more preserved. There are some shrubs on the way that don't let people step on the grass. (...) You can see several types of fruitful plants, there is a blackberry plant there, the ground here turns all red with lots of blackberries on the ground, some bamboos on the side, a "jamelão" plant back there."	13	32
	Generic answer without justifying.	yes; no	"(...) But for me it's great, I think here is very beautiful at night there are some green lights."	10	
	Answer based on comparison between other natural spaces.	better than other green spaces; cities; countries	"Yes, compared to the US, yes."	6	
	Assumes not being able to justify the answer, although has sure of it"	don't know nothing about plants; lay to say; without technical knowledge to comment.	"My botanical background knowledge is awful, but it's beautiful here. It's nice, quite diverse."	3	
No	Answer based on observation of space and plant characteristics.	all trees look the same; not biodiverse	"Not at all. There are different trees, but they all look the same."	7	11
	Generic answer without digression.	yes; no	"No."	3	
	Answer based on observation of space and plant characteristics.	less biodiverse than in natural biomes	"No, of course not. You can see, I don't know, around only 50 types here, less maybe. And São Paulo city is a region of Atlantic Forest, so you should expect hundreds, maybe thousands of Atlantic Forest trees."	1	
Was not able to define properly	Generic answer without digression.	similar trees; some different types; not too much.	"There are many types of plants, but I think it is the expected here."	8	10
	Answer based on comparison between other natural spaces.	few individuals of each species; different from other countries.	"I don't know if it is that rich in diversity. Leaves seem very close, I don't know tree names and stuff, but there are some bamboos there, it seems to have some diversity, more than any other university in Canada, for example."	1	
	Assumes not being able to justify the answer, although has sure of it"	don't know; don't understand; not able to say.	"For me, there is no difference, because I don't know plant species at all. So, there is no way I can tell if here is diverse or not."	1	

Table 2. Content analysis referent to what a green space needs to have to be considered as a "good" one.

What do you think this green space (or any other) should have to fulfill its function of green space?					
Category	**Description of answer**	**Units of record**	**Example of answer [loose translation to English]**	**Number of mentions**	**Total**
Environmental, ecological reasons	Have plenty of plants or life forms in general, without mentioning species richness	grass; green area; visual green; density of trees; bush; more trees; remove concrete/walk spaces; space covered by plants; lots of trees.	"Must have a greater concentration of green area than built area." "(...) If it were only grass, just some benches, it would be great."	33	67
	Have biodiversity, with richness and abundance of different and native types of plant species.	biodiversity; species richness; native plants; native trees.	"It should have a relatively large space, about 10 m^2, with tall and big trees, with a variety of species." "It should have at least few different species, so to not become like a "green desert"."	12	
	Vegetation that provides scenic beauty, greater contact with nature.	contact with nature; harmony with buildings; landscape; beauty.	"It has to be a nice place, with contact with nature, so you can sit down and have such natural experience."	10	
	To promote thermal control or environmental quality of soils.	plant nutrition; shadows; lower thermal sensation; water	"It must have enough plant shades (...)" "Lots of plants to drain water and create shades."	7	
	To have fruitful species or elements such as flowers, to promote equilibrium with other biotic elements.	fruit plants; fruit trees; flowers.	"At least some fruitful trees, or flowers. Starting with the flowers."	5	
Structural, zeal, maintenance reasons	Structural maintenance of the green space, and accessibility promotion.	accessibility; well taken care space; tidy sidewalks; leisure space; well-established space; lighting; waste bins.	"I guess it would just need to fix this sidewalk, people always stumble here." "I think sidewalks should be tidier, there is a misfit rock right there, and some holes too. If someone blind comes here, he/she can stumble."	23	34
	Provision of leisure and socialization and facilities.	benches; leisure space; rest.	"A green space should have a place so we can stay, some benches for the lazy ones to sit."	8	
	Provision of pruning and gardening resources or identification facilities.	pruning trees; caution; zeal.	"(...) maybe chopping, pruning trees correctly so they look cute, with less disoriented branches."	3	

Fonte: autores.

large amount number of plants – although not specifying how much the area should have (Table 2). Non-natural but structural elements, such as benches and park tables and a well-maintained, well-lit and accessible green space were also mentioned elements that a "good" green space should have.

When we asked the respondents to look around IME green space and roughly estimate how many types of plants they could distinguish, most of them said numbers up to 10 (Figure 4A) and associated the concepts of "different types of plants" with the concept of "species", as we expected. For comparison purposes, we highlight that IME landscape has at least 47 documented arborescent plant species, and ca. 20 of those were planted in the local of the interview, based on "Árvores USP" preliminary checklist, as well as on our previous personal examination and on works such as Mendonça (2004).

Finally, when we crossed the data of the number of different types of plants estimated by respondents with their opinion about IME green space being rich or diverse in different types of plants, we found statistical difference at a 5% significance level (Figure 4B). In other words, those who declared that IME green space is rich and diverse with respect of different types of plants were statistically also the ones who estimated higher numbers of different types of plants, although with a high variance in responses.

3.3. Distinguishing individual different types of plants

Only 22% of respondents (13 individuals) could distinguish correctly the six photos as six different types of plants (Figure 4C). 33% of them (20 individuals) distinguished four different types of plants, gathering palm trees (Figures 2A and 2E) as a unique type and "chapéu-de-sol" and "pata-de-vaca" (Figures 2B and 2D, respectively) as another. Those who discriminated five different types clustered only palm trees as a unique type. Respondents who distinguished three types of plants clustered "cica" (Figure 2F) on the same group as palm trees. Lastly, the one individual who distinguished only two different types of plants of the six photos grouped "cica" as an isolated group from the rest. The leaves were the most mentioned attribute to discriminate different types of plants in the photos, according to respondents (42% of a total of 96 mentions), considering their morphology, size and general form (Table 3). Other structures such as general physiognomy (height or lifeform) and stem (trunk type and bark) were less mentioned.

Table 3. Content analysis referent to which criteria respondents used to distinguish the six plants shown in the photos.

Which criteria did you use to distinguish the photos of different types of plants?				
Category	**Description**	**Units of record**	**Number of mentions**	**Total**
Leaves	Format of leaves.	format of leaves; type of leaf; foliage; leaves.	39	**40**
	Color of leaves.	color leaves.	1	
Physiognomy	Size or height of the plant.	height; size; lifeform.	20	**26**
	Tree canopy shape.	physiognomy.	6	
Stem	External morphology of stem and bark.	trunk; trunk type; stem; stem type; bark; stem texture.	21	**25**
	Stem branches.	branching; branch shapes.	4	
Generic criteria	Visual similarity, general appearance, without detailing clearly the criteria.	visual similarity; appearance.	5	**5**

When asked if any of the presented species in photos were exotic, 43% of respondents (21 individuals) did not know or declared unable to answer. Those who answered said there was at least one exotic species, mentioning "pau-ferro" (native to Brazil) and "cica" (non-native to Brazil) as exotics (Figure 2C and 2F), tracing an interesting analogy between morphological characteristics of such plants with leaves and bark morphology of temperate plants, such as pines or eucalypti. Moreover, it is noteworthy that respondents associated the concept of "exotic species" to "unusual" or "odd" ones, treating them as synonyms.

Lastly, only 12% of the 49 respondents claimed to have never seen the plants showed in the six photos, whereas the remaining 88% said the plants were common in Brazil's urban landscapes, mostly in green spaces, flowerbeds and other spaces inside the *campus* or other urban areas. Nevertheless, only 16% of all respondents properly identified at least one of the six plants on photos, naming only the palms as "palm trees" or "coconut trees", but not going beyond that.

3.4. Potantial impacts of plaqued trees

We found no relevant differences on respondents' performance when comparing interviews before and after plaques installation. Thus, we analyzed all further questions for the latter sections considering the whole assemblage of respondents and not each group separate instead. At the end of survey, we informed all respondents about installation of informative plaques on several species of IME green space and registered their reaction. 71% of respondents (37 of 49 individuals) mentioned such action is important and valid, given their own curiosity and the need to empower scientific literacy. Other 22% (11 respondents) declared to be "indifferent", justifying it "would not be that useful", since information about plants is not something they deal with in their daily life or at work (Table 4).

4. Discussion

4.1. Biodiversity perception and plant blindness

Our results suggest that respondents underestimated the richness of different types of plants. Respondents also could not identify correctly different selected species in the photos. Similar works with plants and animals reveal the same panorama (CHEN; ADIMO; BAO, 2009; DALLIMER *et al.*, 2012; MURATET *et al.*, 2015; PALLIWODA; KOWARIK; VON DER LIPPE, 2017; SCHUSSLER; OLZAK, 2008; SHWARTZ *et al.*, 2014; VOIGT; WURSTER, 2015). In the next paragraphs, we shall discuss possible reasons and implications of such "biodiversity blindness" when identifying, valuing and estimating different types of plants.

Firstly, regarding the distinction of native and exotic species, as there is no aesthetical preference about rather the plant is native to a region or not, green space managers should choose native elements to compose a green space. This is because native species should be prevalent in such areas due to their ecological benefits, enhancing biodiversity conservation in all ecosystems (MCKINNEY, 2002). As also discussed by McKinney (2002), native species in urban areas also can promote ecosystem processes and services in the place they were once planted.

Secondly, in the case of IME green space passersby, the perception of what should be considered a "good" green space is not directly related to the origin of the plant itself, but actually to its aesthetic and functional values (e.g. creating shadows or land space for symbolic animals such as birds or small mammals). In other words, we believe that when respondents conceive a "good" green space", they generate the following expectation: a green area, comfortable to socialize and to chill out. Consequently, further important functions that a green space can also provide, such as ecological interactions between

Table 4. Content analysis referent to the relevance of know information about plants and their diversity.

Do you find relevant or would you like to know information of IME plant species? Why?				
Category	**Description of answer**	**Example of answer [loose translation to English]**	**Number of mentions**	**Total**
Yes	Justification based on the need of open access information, scientific literacy, knowledge appropriation for all, or just intrinsic curiosity.	"Because it is important for people to know, that is why it should have a plaque. For example, if the plant is rare, it is important for all to know. Both as curiosity and because it is really important."	18	37
		"Well, I miss have more knowledge of such things, to be less ignorant in the matter; not that knowing plant species has any direct implication in my daily life."		
	No justification or generic answer.	"It's nice to know."	11	
		"Yes."		
	Justification based on the utilitarian value of plants.	"There are some important historical plants that we should know, some fruitful trees. The plant itself does not matter to me. It would be like a utility."	5	
		"To a biologist it is something important to care about. For a [layman] person, I would say, thinking on leisure, this plant is nice because it cools the environmental temperature somehow; or visually it matters, if someone cares about it.		
	Justification based on affective or symbolic value of plants and vegetation.	"As I were raised in a very green, rural environment, it is relevant, very important. Because knowing what we have in the space means know the space as a whole."	3	
		"Well, sometimes I think so, because depending of the plant species people tend to care more."		
Indifferent	Claims that makes no difference to know such information.	"If you want to talk [about plant identification], you can talk."	11	11
		"It's something fun, but it is not an issue that I would research. If I eventually hear about it, OK then."		
No	Does not justify, or generic answer.	"No, honestly."	2	1
		"No. I would forget right after."		
	Justification based on the fact plant knowledge does not interest him/her, since it does not belong to his/her daily-life.	"For me, I don't think so. I think that knowledge only matters to those who works with plants."	1	

the local native fauna and flora, end up being left aside, which is clearly a "symptom" of plant blindness.

For plants, several works have pointed out the reason of prevailing a latent degree of plant blindness in urban spaces is essentially neurophysiological and evolutionary (HARRIS, 1998; VUL; NIEUWENSTEIN; KANWISHER, 2008; WANDERSEE; SCHUSSLER, 2001). On the other hand, Schussler and Olzak (2008) tested two hypotheses: (1) when comparing plant and animal identification skills of a population of students, they would be more successful in identifying animals; and (2) different genders have different performances on the survey. Both hypotheses were corroborated, but the authors discussed that the fact women had shown better performances than men might be actually associated to closer interactions the first would have with nature, and therefore this would be actually a consequence of markers of social difference in gender rather than evolutionary of physiological factors.

In this sense, alternative theoretical currents allied to empirical evidences have suggested cultural and not only innate, natural effects in determining plant blindness (BALAS; MOMSEN, 2014; PALLIWODA, KOWARIK; VON DER LIPPE, 2017; VOIGT; WURSTER, 2015). This makes sense as, if the determinant factor was strictly physiological, plant blindness should be absolutely universal in all societies of the globe, including those who historically have had major contact with nature and plant elements, regardless of being men or women, child or adult, illiterate or highly-educated. Still on that matter, evidences have suggested that people from high or low-income countries have different performances in estimating species richness as well (FISCHER *et al.*, 2018; LINDERMANN-MATTHIES, 2010; 2017). Therefore, even within the urban context, identification skills and environmental perception depends on a series of cultural factors, such as being part of a specific group, religion, tradition or habit that involves a particular relationship between an individual and a plant element (INGOLD, 2004), allied to the individual's educational background (URSI *et al.*, 2018), which is also cultural.

Since our sampling universe comprised mostly men, we cannot conclude much with respect to different gender or age biases in biodiversity perception. Anyhow, those potential biases should not be underestimated, and we strongly believe there is a plenty scope towards assessing these in future works. Besides, we encourage novel studies that adopt a quali-quantitative framework, considering variables such as different socioeconomic strata, diversified regions (e.g. urban, rural, indigenous, quilombo areas), religion and habits towards clarifying which factors are hyperactive in plant blindness.

Furthermore, we also attach special importance to the role of education in mitigating plant blindness, whether in non-formal education, such as in parks and botanical gardens, or in schools. In this regard, the teaching of Natural Sciences and Biology, which includes the Botanical approach, is gaining prominence especially in Brazil, a country with high levels of vascular plant species richness (ULLOA-ULLOA *et al.*, 2017). We agree with Ursi *et al.* (2018) that botanical negligence, named by Uno (2009) as "botanical illiteracy" is closely related to plant blindness phenomenon. As a matter of fact, the teaching of Botany, not only in Brazil, has been for a long time subject of criticism, since it has been traditionally characterized as extremely theoretical an discouraging for both students and teachers (HERSHEY, 1996; SILVA; CAVALLET; ALQUINI, 2006; SANTOS, 2010).

Such panorama is intensified in Brazil due to several reformulation in Brazilian National Curricular Common Base ("Base Nacional Comum Curricular", or BNCC), which also have been criticized among specialists and it is still under debate (REIS; MARTINS; ROSA, 2017). For instance, the BNCC does not clearly present any specific citation about plant biodiversity for high schools, so we realize that current curricula are also being constructed from a strictly zoocentric perspective. This is not any novelty, as similar conditions can be found in other Western societies, and plant blindness is certainly directly tied to that (WANDERSEE; SCHUSSLER, 1999). Hence, Ursi *et al.* (2018) emphasize the need to invest in more dynamic and contextualized forms of teaching that allow the student to be

protagonist of the learning process, improving its scientific literacy. They also highlight the relevance of training qualified teachers to act in basic education, and they point out potential initiatives that have already been structured in such matter. Namely, non-formal education is an important ally in the process of teaching citizens, and, in this sense, we return to the need of maintaining urban green areas for so, as we highlighted in our results.

4.2. Green space expectations and the role of informative plaques

Our study has indicated statistical difference when comparing: (1) estimated plant types in the green space; and (2) whether IME space is rich or diverse in different types of plants. This means that perception of different types of plants had a strong influence in how people characterize a green space that is integer, rich and biodiverse, which is in line with literature in studies performed in other spaces, such as in gardens, parks or in controlled environments (FULLER *et al.*, 2007; LINDEMANN-MATTHIES, JUNGE; MATTHIES, 2010).

However, such statistical difference may be a false positive, especially considering the sample size limitation in this study. We believe the fact most respondents have classified IME green space as rich and biodiverse but did not achieve good performance when distinguishing different types of plants is more related to the expectation's users have about the area. IME green space was not designed to be a space for biodiversity interaction or appreciation, but to be a space for pass by and interaction of IME and USP community. As a matter of fact, the predominant purposes of a green space on a university campus was never biodiversity interaction, but relaxation, leisure and socialization (SPEAKE, EDMONDSON; NAWAZ, 2013).

We must also note that informative plaques could also yield to an opposite effect due to their role of "museumification" of green spaces (GOBSTER, 2007). As plaques individualize plant elements in nature, they can conversely blur the seminal purpose of a green space (leisure, not formal education), thus shifting passersby focus to the plaques and not to nature itself. Nevertheless, even if our study were carried out in a space designed for biodiversity interaction, such as on a botanical garden, participants' performance would not necessarily have been better, since the effect of plant blindness is prevalent. Even in such spaces, visitors do not have the expectation of interacting with biodiversity, but relax, socialize and appreciate the aesthetics of vegetation, facing it as a homogeneous component of landscape (PALLIWODA; KOWARIK; VON DER LIPPE, 2017).

Respondents often use "diversity" to express a subjective value associated to aesthetic and well-being characteristics of IME green space, and when we asked an objective parameter ("how many types of plants can you see?"), they could not express their feeling about it, although highlighted the importance of biodiversity and recognized the consequences of its loss. Biodiversity perception was limited, underestimated, and such estimation is more associated to perception of ecosystem services provided by species than due to morphological characteristics that distinguish one plant from another (BELAIRE *et al.*, 2015; SCHUSSLER; OLZAK, 2008).

Due to the fact our paper is characterized as a quali-quantitative study (FLICK, 2009), we could not evaluate if plaques changed the perception of respondents, since we did not interview the same people before and after trees were plaqued. In addition, it would be necessary to conduct a study for a longer period to access whether plaques had any impact on passersby perception. And even then, accompaniment would be biased in a way, as it would be necessary to interview the same individuals more than once.

Nonetheless, Shwartz *et al.* (2014) argue the difference of perception before and after installation of informative plaques should be significant in green spaces were its design and maintenance were collaborative and organized by local community in partnership with the funding institution. Nonetheless, we believe plaques installation in green spaces which were not designed to the finality of biodiversity interaction, as occurs in IME, also generates a kind of

"expectation conflict" on passersby. Once visitors perceive informative plaques on a green space, they unconsciously begin to show a plaque-mediated interaction with biodiversity, individualizing plant elements that were once homogenized as single landscape components and thus valuing it even and changing their expectations about the green space. Most respondents assigned an identity to the plant species of IME, as they show ecosystem services provided by them (e.g. flowering season, if there are any known medicinal uses, if the plant is edible), which is precisely what, as we just mentioned on the last paragraph, make passersby perceive plants in a different, more intimate and therefore "less blind", way.

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