Ficus benjamina L. in the cities: high number of individuals, severe damages to infrastructure and expensive economic losses

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Abstract

The article examines the rather negative impact caused by *Ficus benjamina* on urban areas in tropical and subtropical zones, specifically, Colombia, Mexico and Brazil. Considered erroneously, by many as an appropriate species for urban tree planting, given its ornamental value, its low cost propagation and adaptability to urban stress, *F. benjamina* has been introduced massively on hot weather cities to the extent of becoming the predominant species. However, the roots of the *F. benjamina* have proven to be destructive of urban structures (foundations, streets, sidewalks and water systems, among others), which affect considerably the economy of the cities, yet some botanists currently conduct studies that, in fact, seek for more efficient methods of propagation of this species and promote its usage on urban settings, disregarding the widely accepted implications caused by *F. benjamina* and encouraging with their work a damage-repair cycle that undermine public and private financial resources in poor, developing or emerging countries.

Keywords

Urban tree planting, urban economy, urban ecology, landscaping.

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Ficus benjamina L. en las ciudades: altas poblaciones, daños severos a estructuras físicas y grandes pérdidas económicas

Resumen

El artículo analiza el impacto negativo generado por la presencia de Ficus benjamina *en áreas urbanas de zonas tropicales y subtropicales alrededor del mundo, haciendo énfasis en Colombia, México y Brasil. Por considerarse erróneamente, especie apropiada para arborizaciones urbanas,* F. benjamina *ha sido introducida en muchos países, y por sus características ornamentales, bajos costos de propagación y adaptación al estrés urbano, se ha plantado masivamente en las ciudades de clima cálido, siendo en muchas ocasiones la especie predominante. Sin embargo, las raíces de* F. benjamina *generan severos daños a las estructuras urbanas (cimientos, calzadas, redes de alcantarillado, entre otras), lo que impacta gravemente la economía de las ciudades. Algunos botánicos realizan actualmente investigaciones que buscan una más eficiente propagación de esta especie, y la promueven como apta para los espacios urbanos, viendo en ello un recurso económico. Pero es evidente que esos investigadores desconocen los severos daños causados por* F. benjamina *en las ciudades, y con sus trabajos, fomentan un círculo vicioso que mina los recursos públicos y privados de muchas economías pobres, en desarrollo o emergentes.*

Palabras clave

Arborizaciones urbanas, economía urbana, ecología urbana, paisajismo.

Introducción

The *Ficus benjamina* L. is a species of fig tree native to a vast region, including, India, China, Southeast Asia, Malaysia, the Philippines, the South Pacific and the northern part of Australia (Riffle, 1998), which, by means of its ornamental value and its adaptability to urban environments, have been introduced massively as part of urban tree planting programs in many countries located in tropical and subtropical zones. Nowadays it is present in countless cities in different countries such as Brazil, Chile, Colombia, Costa Rica, Cuba, Spain, United States, Mexico, Turkey, Paraguay, Pakistan, Dominican Republic, Singapore and Venezuela, just to name a few in which *F. benjamina* holds a significant place in urban tree planting.

The constant presence of *F. benjamina* in cities, especially in those with hot weather, relies on the fact of being an easy-to-grow, very adaptable species (Dominí & Benítez, 2004: 45) and of its thermoregulation performance on public spaces. Studies conducted by Jiménez (2007) in Barranquilla, Colombia, depict that at noon, under the shadow of *F. benjamina*, temperature drops up to 10°C in comparison to those areas exposed to direct solar radiation, where it reaches 37°C. This is due both to the high density of its foliage and to its dimensions (height and diameter).

Hence, high current demand of *F. benjamina* for urban tree planting programs worldwide has benefited croppers, for whom it has become a great business opportunity especially in developing or emergent countries, and botanists who now have engaged in multiple researches focused on how to propagate *F. benjamina* more efficiently, such as Dominí & Benítez (2004) in Cuba, Ibrahim (1992) in Egypt, Soto et al (2006) in Mexico; Alvarado (2004) in Bolivia and the Department of Horticulture Kwame Nkrumah University of Science and Technology in Ghana, among others.

But, from the point of view of architecture and urbanism, planting *F. benjamina* on metropolitan areas is absolutely inadequate, since it causes severe damage to city structures. Its roots are aggressive, superficial, thick, very strong, and grow up to a hundred meters long (Toscan et al, 2010), which enables them to fracture concrete (Starr et al, 2003), affecting foundations and walls on houses and buildings, as well as civil works like bridges and street posts, roads and streets. Also, in their search for water, roots from *F. benjamina* break and/or obstruct underground pipes from water and sewage systems (Martelli & Barbosa, 2010; Alanís Flores, 2005; Almeida & Rondon Neto, 2010; Vargas-Garzón & Molina-Prieto, 2010). As shown in the following pages, many researchers have reported severe damages caused by *F. benjamina*, which undermine public economic resources in poor countries because the money flow to fix them is often substantial, continuous, and only stops when the tree is finally cut down. Paradoxically, although *F. benjamina* has been reported for the damages caused to urban areas all over the world, it is a predominant species in hot-weather cites, not only in Colombia but in other countries located in tropical and subtropical zones.

Materials and Methods

Fieldwork was conducted on three Colombian cities (Villavicencio, Neiva and Ibague), where damage to urban infrastructure caused by *F. benjamina* was evident. In each city, on top of direct observation, professionals responsible for urban tree planting programs were interviewed, and information (research results and official reports emitted by local institutions) where damages caused by *F. benjamina* were documented and gathered. Also, scientific articles from all over the world that majorly consider *F. benjamina* to be a non appropriate species for urban tree planting were revised.

Characterization of the study area

All cities included in this study are located in Colombia, each one of them situated on a different region, allowing for some particularities. **Villavicencio:** the state capital of Meta, it is located on the plains of the country, on the foothills of the eastern range of the Andes. Elevation: 467 meters. Average temperature: 28°C. **Ibague:** the state capital of Tolima, it is located in the central range of the Andes, in the middle part of the country. Elevation: 1,285 meters. Average temperature: 24°C. **Neiva:** the state capital of Huila, it is located on a plateau between the central and eastern ranges of the Andes, on the right bank of the Magdalena River, in the southern part of the country. Elevation: 442 meters. Average temperature: 28°C to 37°C, depending on the time of the year.

Results

◈***Ficus benjamina*** in hot-weather cities: predominant specie
The three Colombian cities referred to in this study have an average temperature between 24°C and 37°C (they endure hot weather all year long), which benefits the initial fast growth and the latter development of *F. benjamina*. In all three of them, *F. benjamina* is a predominant species on streets, highways, river banks and parks. To illustrate the amount of individuals of *F. benjamina* on these cities, table 1 depicts the results obtained in Villavicencio (Meta).

Here, it is quite evident that *F. benjamina* is one of the predominant species in Villavicencio (3.679 individuals, which amount to 33,51 % of the urban trees). Also, the table makes clear that introduced species are more common than native ones in a 10:1 ratio.

In the other two Colombian cities studied (Neiva and Ibague), although there was no survey as in Villavicencio, the primary presence of *F. benjamina* was confirmed by direct observation on site and by the information provided by those in charge of urban tree planting in each city. Same thing happened in other hot-weather cities in the country like Medellin, Cali, Cartagena, Barranquilla and Santa Marta, among others. Such trend is equally observable in cities from different countries, including, Brazil, Mexico and the Dominican Republic. Table 2 presents the results gathered by researchers in Brazil and Mexico.

Table 1. Tree species and number of individuals in Villavicencio, Colombia

Introduced species	Number of individuals
Araucaria excelsa	105
Bauhinia purpúrea	147
Cananga odorata	51
Cassia fistula	222
Cassia siamea	88
Cocos nucífera	339
Crysalidocarpus lutescens	191
Elaeis guineensis	91
Ficus benjamina	**3.679**
Ficus elastica	44
Mangifera indica	447
Pinus patula	48
Roystonea regia	69
Spathodea campanulata	50
Syzygium malaccense	3.597
Terminalia catappa	496
Total of introduced species	**9.664**
Native species	**Number of individuals**
Anonna muricata	138
Brownea ariza	98
Ceiba pentandra	7
Gliricidia sepium	20
Guazuma ulmifolia	10
Hura crepitans	24
Matisia cordata	27
Melicoccus bijugatus	72
Ochroma pyramidalis	14
Persea americana	136
Piptadenia peregrina	119
Pithecellobium dulce	268
Psidium guajaba	185
Samanea saman	17
Spondias purpurea	10
Tabebuia rosea	168
Total of native species	**1.313**
Total number of individuals planted in Villavicencio:	**10.977**

Source: Luis Fernando Molina-Prieto & Bellanith Vargas-Garzón (Authors), based on data from Bernal (2000).

Table 2. *Ficus benjamina* in Mexican and Brazilian cities

Country	City	Study area	Total number of individuals	Number of F. benjamina	Percentage of F. benjamina
Brazil	Patos	Bivar Olinto (neighborhood)	164	114	69.51 %
Mexico	Linares	Downtown	922	399	43.27 %
Brazil	Petrolina	Downtown	3.130	1289	41.21 %
Mexico	Morelia	Five avenues	1.400	507	36.21 %
Brazil	Carlinda	Streets and avenues	102	28	27.45 %
Brazil	Alta Floresta	Streets and avenues	322	78	24.22 %
Brazil	Nuevo Iguazú	Rancho Novo (neighborhood)	560	121	21.61 %
Brazil	Itapira	Trees cut down by the city for causing damages	119	25	21%

Source: Luis Fernando Molina-Prieto & Bellanith Vargas-Garzón (Authors), based on data from Lira Filho et al (2005), López & Zamudio (s. d.), Oliveira et al (2010), Conejo (2011), Almeida & Rondon Neto (2010), Da Rocha et al (2004), Martelli & Barbosa (2010).

Here it is noticeable that *F. benjamina* is the predominant species in many of the cities shown and most of all, is alarming to acknowledge that it can represent almost 70% of the urban trees existing in one neighborhood (Patos, Brazil), even more if accounting that in the upcoming years it will be the primary cause of substantial detriment to urban infrastructure and of not very cheap repairs that will necessarily affect local inhabitants and will undermine significantly the economic assets of the city.

Some other studies reveal very similar results: In Linares, Mexico, the participation of *F. benjamina* in urban tree planting increased from 15% on 1995 to 42% on 1999 (López & Zamudio, 1999). In Mexico D. F., although there is no official survey, it is worth mentioning that on 2010, *F. benjamina* was the species selected as biological indicator for conducting a study on urban pollution, which clearly indicates its extensive presence in the city (Guzmán-Morales et al, 2011). In the metropolitan area of Monterrey, México, during the 1990's "surrounding cities of this location have all planted ficus trees (*Ficus benjamina*) to a great extent because of their low cost" (Alanís Flores, 2005: 28). In Tlaxcala, Mexico, even though there is no detailed survey, researchers conclude that *F. benjamina*, among other four introduced species, has been planted along city streets as monoculture (Santacruz, 2007: 78). According to Santo Domingo's City Hall in the Dominican Republic, *F. benjamina* is a species "present all over the city" (ADN).

◈Severe damages in urban structures caused by *Ficus benjamina*

In a recent study hired by Villavicencio's City Hall in Colombia (Bernal, 2000), 3.478 severe damages caused by *F. benjamina* were found to the sewage system, meaning, breaking and blockage of underground water supply piping. How much does it cost to repair those thousands of damages to Villavicencio's mayor's office? Accounting breaching the asphalt layering, excavating, cutting apart the tubes, taking out the roots causing the obstruction, cleaning up and transporting the debris, buying new pipes to replace the damaged ones, bringing them to the site and installing them, stabilizing the ground

again and paving the surface, a modest calculation of three thousand dollars (US $3.000) to repair each one of those 3.478 severe damages (although a real budget will definitely be a lot more), would cost more than ten million dollars (US $10´434.000 to be exact), a significant amount for a city with huge needs and low economic resources (e.g. that money would be more than enough to build a hospital or a public school). Lest we forget, since most of these damages take place under the city streets, they must be partially or totally closed at the time of the intervention (days or weeks), which necessarily affects urban mobility by means of traffic jams, a condition that undoubtedly reduces the economic activity of the city and, hence, its income.

In the other two Colombian cities, Neiva and Ibague, due to the large population of *F. benjamina*, damages throughout underground sewer networks have been detected, even along pipe stretches of more than 80 meters long. As a result, the mayor's offices of both municipalities have emitted norms that not only prohibit the sowing of *F. benjamina* but also recommend the cutting down of all individuals of the species inside urban perimeters (Consejo de Neiva, 2003; Consejo Municipal de Ibagué, 1989). However, these legal dispositions have not yet been complied with as of now.

In some other countries, as well, damages caused by the roots of *F. benjamina* have been denounced: in Foz do Iguazú, Brazil, *F. benjamina* is considered to have damaged sidewalks and water and sewage systems because they "have roots that can reach more than a hundred meters long" (Toscan et al, 2010: 176). In Itapira, Brasil, "the results of this study corroborate the findings of Santana & Santos (1999) that point out *F. benjamina* as one of the most harmful trees to sidewalks and city structure" (Martelli & Junior, 2010: 104). In Iguazu, Brazil, "*F. benjamina* is considered harmful for the city street system given the damages" (Da Rocha et al, 2004: 601). In Goiandira, Brazil, *F. benjamina* is not suitable for street landscaping (Teixeira et al, 2010: 191). In Campina Grande, Brazil, damages to roads, constructions and walls caused by *F. benjamina* and other not appropriate species are reported (Soares de Medeiros & Coelho Dantas, 2007). In Curitiba, Brazil, *F. benjamina* is responsible for damages to urban infrastructure (Klechowicz, 2001). In Jatai, Brazil, the rising number of *F. benjamina* "can bring along structural damages and serious problems to the city" (Barros et al, 2010: 292). In Monterrey, Mexico, *F. benjamina* has caused damages to sidewalks and water and sewage systems (Alanís Flores, 2005: 29). According to Santo Domingo's city hall in the Dominican Republic, the roots of *F. benjamina* are "too developed and cause the rupture of sidewalks and underground pipes" (AND). In Hawaii, United States, a study on *F. benjamina* asserts that "Some disadvantages

to this tree in cultivation include adventitious roots both above and below ground which can break up concrete surfaces" (Starr et al, 2003).

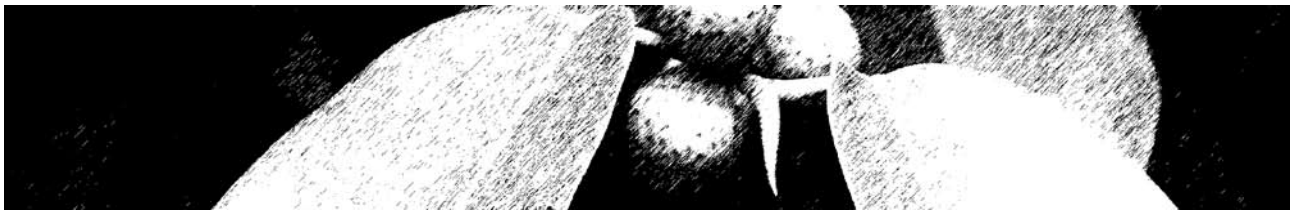
Discussion

All data collected during field work, plus the comprehensive scientific literature cited in the article, indicate evidently that F. benjamina is not a good choice for urban tree planting because of the damage it causes to the physical structure of cities and the cost associated to those reparations. However, some authors, like Dominí & Benítez (2004) or Gandarilla & Fernández (2002), still consider that *F. benjamina* is of great economic importance to the extent of focusing their researches to the efficient propagation and plant nursery of this species, and encourage its use as an "ornamental" tree for urban areas. Undoubtedly, these authors overlook the damages caused by the roots of *F. benjamina*, which, in a medium-to long-term period will represent constant valuable expenditures that exceed considerably the revenues collected with its sale. In other words, the breeder —or the plant nursery— receive 5 to 10 dollars for a *F. benjamina* ready to plant (that is the actual price today in Colombia), but ten or fifteen years later the city would have to invest thousands of dollars to repair the damages caused by this same one individual once it has become an adult. As time passes by the damage-repair cycle repeats over and over again until the tree is finally cut down, a solution that is also very worthy for the city economically and environmentally speaking. Is it a gain or a loss? A petty gain for the breeder (the 5 to 10 dollars charged at the plant nursery) and a tremendous loss for the city (the thousands invested to fix the damages).

A tree is considered inappropriate to be planted in any given city not because it is cheap or it propagates easily at the nursery. A tree is considered appropriate to be planted in any given city when its roots do not damage urban structures (houses, buildings, city streets, pedestrian walkways, bridges, and water and sewage systems) and when it enhances symbiotic relationships with its surrounding tree and animal species. *F. benjamina*'s advantages, besides its ornamental value, resides merely on the fact that it can be easily cropped and propagated in a plant nursery and that makes it inexpensive for commercial purposes. But when it leaves its pot at the garden and goes out to any urban environment, its roots go through concrete and pavement, causing sever damages to the infrastructure of the host city, as it has been reported from all corners of the world.

Conclusions

Damages caused by *F. benjamina* to urban infrastructure in cities and the elevated cost associated to its repair could be easily overturn just by planting other species, especially those ones with non-aggressive roots. But while there are botanists researching and publishing articles about *F. benjamina*, promoting its cultivation without warning readers and breeders about its harms to constructions, architects and town planners, as well as any other inhabitant of cities will keep planting them in oblivion. It is of great importance that botanists study conscientiously the medium-to long-term impacts that any specific species may have on urban infrastructure before initiating a research related with the propagation of "ornamental" trees which will end up in the streets of a city.



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