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Original article

Harmful organisms in urban trees in the city of Pinar del Río, Cuba

Organismos nocivos en el arbolado urbano en la ciudad de Pinar del Río, Cuba

Organismos nocivos em árvores urbanas na cidade de Pinar del Río, Cuba

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ABSTRACT

The present study was carried out in the neighborhoods "Hermanos Cruz", "Carlos Manuel", "Montequín" and "Calle Martí" belonging to the municipality of Pinar del Río, with the aim of identifying causal plague organisms associated with urban trees in the city of Pinar del Rio, Cuba. A floristic inventory of forest trees was carried out up to the family and species level, as well as the collection of samples of plant organs with symptoms of parasitic diseases and/or the presence of phytophagous insects. The

inventory of urban trees in the city of Pinar del Río revealed 13 forest species belonging to 9 botanical families and 12 genera. The most represented family was Meliaceae. In addition, the "Hermanos Cruz" distribution presented a greater abundance of forest species. The species of urban trees serve as hosts to 21 harmful organisms that include eight causal agents of parasitic diseases, 3 orders, 11 families and 13 species of phytophagous insects, with a greater representation of Hemiptera and Lepidoptera. Harmful organisms showed a greater presence in the forest species like *Callophylum antillanum*, *Grevillea robusta*, *Acasia mangium*, *Hibiscus elatus*, *Gmelina arborea, Tectona grandis* y *Eucaliptus sp*.

Keywords: Phytophagous insects; Effects; Parasitic diseases; Forest species.

RESUMEN

La investigación se desarrolló en los Repartos "Hermanos Cruz", "Carlos Manuel", "Montequín" y "Calle Martí" pertenecientes al municipio Pinar del Río, con el objetivo de identificar organismos causales de plaga asociados al arbolado urbano en la ciudad de Pinar del Río, Cuba. Se realizó un inventario de árboles forestales hasta nivel de familia y especie, así como recolección de muestras de órganos de las plantas con síntomas de enfermedades parasitarias y/o presencia de insectos fitófagos. En el inventario del arbolado urbano de la ciudad de Pinar del Río se obtuvo un total de 13 especies forestales pertenecientes a nueve familias botánicas y 12 géneros. La familia más representada fue Meliaceae; mientras que, el reparto Hermanos Cruz presentó mayor abundancia de especies forestales; las especies forestales del arbolado urbano presentaron 21 organismos nocivos, constituidos por ocho agentes causales de enfermedades parasitarias, tres órdenes, 11 familias y 13 especies de insectos fitófagos, con mayor representación de Hemíptera y Lepidóptera. Los organismos nocivos mostraron mayor presencia en las especies forestales *Callophylum antillanum*, *Grevillea robusta*, *Acasia mangium*, *Hibiscus elatus*, *Gmelina arborea, Tectona grandis* y *Eucaliptus sp*.

Palabras clave: Insectos fitófagos; Afectaciones; Enfermedades parasitarias; Especies forestales.

RESUMO

A investigação foi realizada nos bairros "Hermanos Cruz", "Carlos Manuel", "Montequín" e "Calle Martí" pertencentes ao município de Pinar del Río, com o objetivo de identificar organismos causadores de pragas associados a árvores urbanas na cidade de Pinar del Río, Cuba. Foi realizado um inventário das árvores florestais até o nível de família e espécie, bem como a coleta de amostras de órgãos vegetais com sintomas de doenças parasitárias e/ou presença de insetos fitófagos. No inventário da arborização urbana da cidade de Pinar del Río, obteve-se um total de 13 espécies florestais pertencentes a nove famílias botânicas e 12 gêneros. A família mais representada foi Meliaceae; enquanto a distribuição Hermanos Cruz apresentou maior abundância de espécies florestais; as espécies florestais da arborização urbana apresentaram 21 organismos nocivos, compostos por oito agentes causadores de doenças parasitárias, três ordens, 11 famílias e 13 espécies de insetos fitófagos, com

maior representação de Hemiptera e Lepidoptera. Os organismos nocivos apresentaram maior presença nas espécies florestais *Callophylum antillanum, Grevillea robusta, Acasia mangium, Hibiscus elatus, Gmelina arborea, Tectona grandis e Eucaliptus sp*.

Palavras-chave: Insetos fitófagos; Afetações; Doenças parasitárias; Espécies florestais.

INTRODUCTION

Public green spaces fulfill several functions. Their aesthetic value creates pleasant spaces to live. They also improve air quality by trapping polluting particles and substances, prevent erosion, and attenuate auditory impact. Moreover, they play an important role in recreation and distraction. Therefore, it is justified to make efforts to implement and keep them from the municipal management (Bahamonde *et al*., 2018), where tree species play an important role.

It can be said that urban trees generate innumerable contributions to the city at all levels, both social, economic, ecological, environmental, cultural and in terms of human health (Molina and Acosta 2018).

In order to secure its proper management and handling, it is essential to know the species that compose it. The purpose of the sampling is to identify the phytophagous species that, due to their high reproductive potential, take on the character of a pest and cause serious damage to the plants they feed on. They also provoke economic losses due to the deterioration of urban furniture, inconvenience to users, and in very specific cases, can negatively affect people's health (Hernández and Marcos 2019).

To fulfill those functions, the planted trees must be healthy, have bright green or matte foliage according to their species and have all their branches growing at an expected annual rate for the species in the environment where they grow. Besides, their trunk must not present cracks; neither inclines nor important bifurcations and not expel liquids by scars, nor be affected by sooty mold. A healthy tree, in general, does not have a significant insect population and its percentage of dry branches is low (<10 %) (Bahamonde *et al*., 2018).

The trees of the city of Pinar Río do not meet the characteristics indicated in the category of a healthy tree. Hence the research was aimed at identifying the causal organisms of plague that are associated with these forest species.

MATERIALS AND METHODS

Description of the research scenarios

The investigation was carried out in "Calle Martí" and the districts "Hermanos Cruz", "Carlos Manuel" and "Montequín", belonging to the municipality of Pinar del Río. Almost all of these scenarios present settlements dominated by buildings, parks and/or uninhabited land where vegetation prevails, mostly forest species.

The determination of the forest species involved within the urban trees in the evaluated areas was carried out through an inventory, in September 2021, considering each green zone and other public spaces (Table 1).

Table 1. - Coordinates of the points sampled in the selected green areas

Urban venues	Geographic location
Martí Street (it covers the main avenue from the Tranquilino Sandalio de Noda Museum of Natural Sciences to the Café Ortúzar Restaurant)	22°24'51''N 83°41'45''O
Cast Carlos Manuel (Comandante Pinares Street)	22°24'59''N 83°41'26''O
Hermanos Cruz distribution (covers Calle Colón to Avenida Borrego)	22°25'17''N 83°41'11''O
Montequín neighborhood (Central Highway in front of Abel Santamaría Cuadrado Hospital)	22°26'26''N 83°40'27''O

In each evaluated area, the species of forest interest were recorded and counted. The floristic inventory was developed from the count and taxonomic identification, up to the family and species level, of the tree plants of forest interest present in the different urban venues and areas with vegetation (Betancourt 2000).

Methodology for the identification of pests associated with tree species of forest interest

The causal agents of diseases were identified using the keys proposed by Hernández (1985). The taxonomic determination of the phytophagous insects found was carried out using the taxonomic keys of Cibrián *et al.* (2007) and data available in CABI (2007). It was also considered, in all cases, the recognition or presumptive diagnosis of these directly in the urban venues evaluated.

The identification and characterization of the specimens was carried out using a Novel® stereoscopic microscope, tweezers, scalpels, among other instruments which allowed the development of dissections, as well as comparisons with existing keys. Those immature stages collected were kept under laboratory conditions, artificially fed until their life cycle is completed with the arrival of an adult insect.

Samples were collected in all the evaluations; each sample was duly labeled with the data corresponding to the forest species and date of collection. In the same way, data and comments that were considered pertinent were taken, at the time of their collection, due to their interest for the determination of the species of harmful organisms, the methodology proposed by Miranda (2011) was considered.

RESULTS AND DISCUSSION

Thirteen forest species were identified in the urban sites evaluated, consisting in six native species (46 %) and seven exotic (54 %), which were grouped into 9 botanical families, 12 genera and 778 individuals (Table 2). Urban green spaces are small ecosystems, although fragmented, they represent a reservoir of biodiversity (Egerer *et al.,* 2018).

These results coincide with Jiménez *et al.* (2015), in studies carried out in the urban trees of Plaza de la Revolucion in Havana, Cuba. However, Rodríguez *et al*. (2018) identified a total of 24 families, 36 species and 1259 individuals in the urban woodland of the city of Guantánamo, Cuba.

Table 2. - Tree species of forest interest identified in the urban trees of the city of Pinar del Río

Family	Scientific name
Verbenaceae	*tectone grandis* L.
Meliaceae	*Swietenia macrophylla* King.
Meliaceae	*Swietenia mahagoni* Jack.
Meliaceae	*Cedrela odorata* L.
Meliaceae	*Khaya nyasica* Stapf.
Malvaceae	*Hibiscus elatus* SW.
cluseaceae	*Callophylum antillanum* Britton
Myrtaceae	*Eucalyptus* sp.
Boraginaceae	*Cordia gerascanthus* L.
Fabaceae	*Acacia mangium* Willd
Proteaceae	*Grevillea robusta* A. Cunn.
Pinaceae	*Pinus caribaea* Morelet.
Verbenaceae	*Gmelina arborea* Roxb.

They stand out for the number of species that group the families Meliaceae (four) and Verbenaceae (two species), the other families were represented by one species (Table 2). Hernandez *et al.* (2019) recorded lower results for Meliaceae with two species. The results also highlight a greater abundance of individuals by species than species by family.

The greatest abundance of forest species was recorded in the "Hermanos Cruz" distribution, with the presence of the 13 inventoried forest species and 450 individuals. These results may be associated with the distribution of the species in the main streets

of the city of Pinar del Río (Figure 1), in addition to the poor management of trees, which leads to the loss and deterioration of established species.

Figure 1. - Images of deterioration of forest species inventoried in the city of Pinar del Río

The trees that inhabit urban environments daily face stressful and precarious conditions, in hostile environments that limit their proper development, which affects their ability to offer the environmental services that a healthy individual could provide (Gilioli *et al.,* 2014).

There is a lack of divulgation and training towards the population about the benefits and importance of trees for the city and for improving the life quality of the inhabitants. Society recognizes in trees mainly their decorative or scenic value and their role in generating shade, leaving aside the rest of the services they provide to cities (Avellán 2020).

Harmful organisms in forest species in urban venues

Regarding the diseases, 8 causal agents of pests were identified (Table 3), in *H. elatus*, *G. robusta* and *A. mangiun* the characteristic symptoms of gangrene and gummosis in *G. robusta* consist of cracking of the bark that affects the xylem and abundant gummy secretion of a brown color. *A. mangium* trees also exhibited brown gummosis and bark cracking.

The most severe symptoms produced by parasitic diseases were observed in trees of *H. elatus* and *G. robusta* (Figure 2), with great damage caused by gangrene. According to Andreu *et al.* (2007), the pathogen that causes this disease is a fungus that has not yet been classified, although it belongs to the Ascomnycetes Class, Hipocraceae family.

Table 3. - Parasitic diseases detected in the evaluated forest species

causal agents	host plant
***Olivea tectonae* Rac.**	Olivea tectonae
***Capnodium* sp.**	*Callophylum antillanum*
***Crysophorte cubensis* Bruner.**	*Eucalyptus* sp.
***Xanthomonas rubrilineans* Starr.**	*Khaya nyasica*
***Tubercularia* sp.**	*Khaya nyasica*
Unidentified	*Hibiscus elatus*
Unidentified	australian oak
Unidentified	*Acacia mangium*

Eucalyptus *sp*. showed severe damage caused by *C. cubensis*. Soares *et al.* (2018) state that cankers are found on tree trunks and branches, and can reduce growth and cause plant death. Eucalyptus canker is one of the most limiting diseases for plantations in the tropical region (Chocontá *et al.,* 2017).

Figure 2. - Gummosis and bark cracking in *Grevillea robusta* (A), Gummosis and bark cracking in *Acacia mangium* (B) and Gangrene in *Hibiscus elatus* (C)

O. tectonae caused severe defoliation symptoms in the teak (Figure 3 B, and C). The rust produces an almost total defoliation of the trees, affecting the photosynthesis process in the plant, but once the infection period has elapsed, they recover and sprout new leaves (Cibrián *et al.,* 2007).

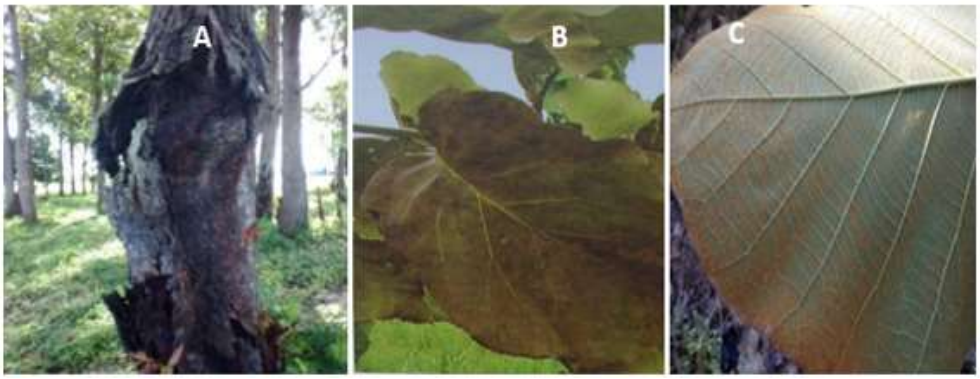

Figure 3. - *Eucalyptus* sp. tree affected by gangrene (A), leaves with green-brown necrotic areas (B) and orange spores of the fungus on the underside of the leaves (C)

K. nyasica trees, the presence of *X. rubrilineans was observed* (Figure 4: A). Although this disease gives an ugly appearance to the tree, over time the galls detach, the trees recover and acquire a certain degree of immunity (Hernández, 1985). In this species, the manifestation of gummosis on the trunk, produced by the fungus *Tubercularia* sp.

Capnodium sp. manifested itself in the form of black crusts on the surface of the *Callophylum antillanum* leaves, reducing their photosynthetic area. The fungi that cause this disease are saprophytes obliged to feed on honeydew excreted by sucking stinging insects of the order Hemiptera.

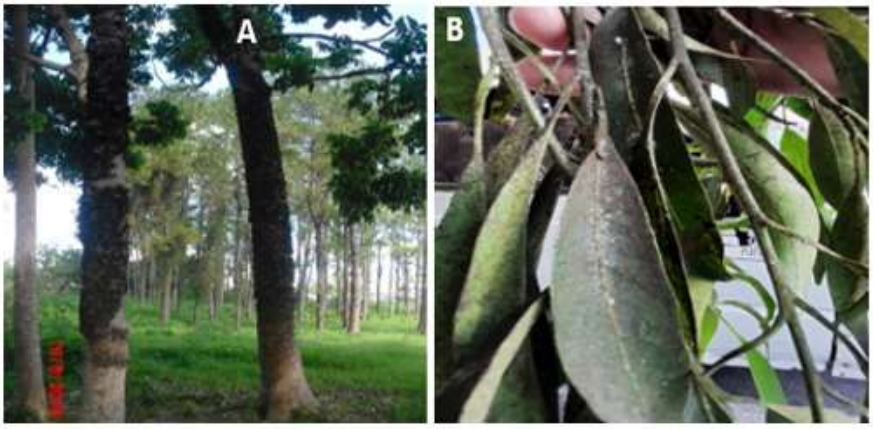

Figure 4. - Hypertrophy on trunks and branches in the form of galls (A) and (B) sooty mold on *Cordia gerascanthus leaves*

Regarding phytophagous insects, 3 orders, 11 families and 13 species were recorded (Table 4). The highest species richness was recorded in the orders Hemiptera (9) and Lepidoptera (3), while the most represented families were Coccidae and Aleyrodidae with two species, respectively.

Similar results were obtained by Méndez (2017), since they found a greater number of families and species in Lepidoptera and Hemiptera.

Reséndiz *et al.* (2019) in urban spaces identified 45 species, included in 34 genera, 18 families and six orders of phytophagous insects.

Table 4.- Phytophagous arthropods found in the evaluated forest species of interest

Order	Family	Scientific name
hemiptera	Diaspiidae	*Unsapis citri* C.
	aphididae	*Toxoptera aurantii B.*
	Coccidae	*Coccus viridis* Green.
		Ceroplastes sp.
	Monophlebidae	*Icerya purchasi M.*
	Pseudococcidae	*Dysmicoccus brevipesC.*
	Diaspiidae	*Selenaspidus articulatusM.*
	Aleyrodidae	*Aleurocanthus woglumi A.*
		Aleurodicus cardini B
	Aphalaridae	*Glycaspis* sp.
Lepidoptera	Noctuidae	*Anomis illita Gen.*
	Olethreutidae	*Episimus condensatanus* Zell.
	Termitidae	*Nasutitermes* sp.

The Hemiptera order expressed the highest presence of insects in the evaluated forest species, showing greater preference in *C. antillanum, A. mangium, G. arborea* and *C. gerascanthus,* which shows that these species could be the most affected by these organisms.

Reséndiz *et al.* (2019) in urban spaces reported species of phytophagous insects, mostly Hemiptera, with families such as Aphididae, Coccidae, Aleyrodidae and Diaspididae, among others.

These individuals usually suck their food mainly from the leaves, tender twigs, developed branches, floral bearings and fruits (Valerazo *et al.,* 2012), in which they find elaborated sap, a fluid composed of simple carbohydrates such as sucrose, glucose and fructose, from which insects take high volumes (Cano 2013) (Figure 5).

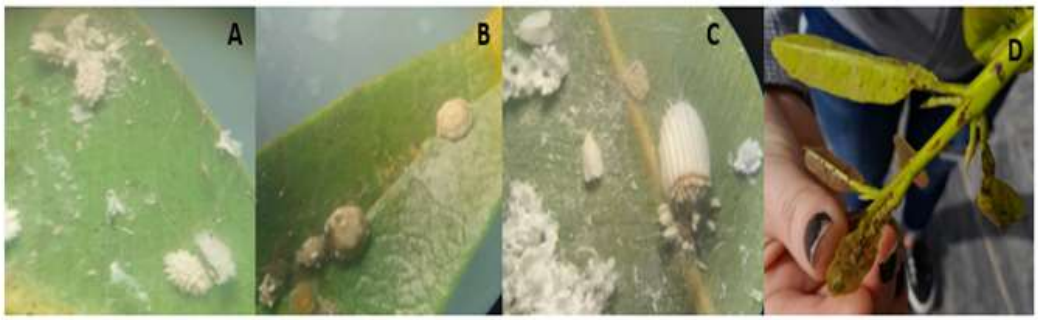

Figure 5. - Images of Hemiptera in Ocuje: *Dysmicoccus brevipes (A), Ceroplastes* sp. *(B), Aleurodicus cardini (C), Icerya purchasi (C), and Toxoptera aurantii (E)*

Frank *et al.* (2019) assures that, when selecting trees for urban woodland, the susceptibility to pests of native species must be weighed against the benefit for the conservation of native urban insect fauna (Figure 6).

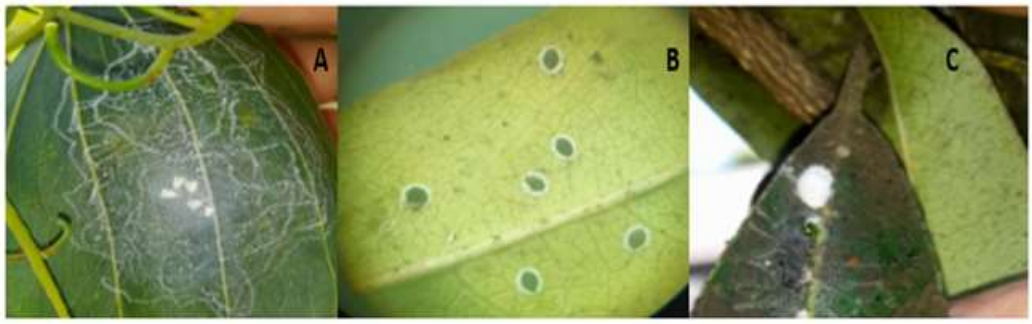

Figure 6. - Images of *Aleurodicus cardini in Acasia (A); Aleurocanthus woglumi (B) and Dysmicoccus brevipes in Baría (C)*

Frank *et al*. (2019) affirms that both the harmful and beneficial fauna that is housed by urban trees, in addition to the geographical origin, respond to the environmental conditions generated in urban environments. In such a way that, to favor conservation and avoid the loss of environmental services in urban trees due to harmful agents, it is necessary to establish a balance between exotic and native species.

Regarding the presence of harmful organisms in forest species, it was found that *C. antillanum, G. robusta, A. mangium, H. elatus and G. arborea,* presented a greater presence of phytophagous insects, while the species *C. antillanum*, *T. grandis*, *G. robusta , H. elatus* and *Eucaliptus* sp., showed a higher presence of pathogens.

The reduced diversification of plant species in some parts of the cities, and even worse, the dominance of a single species, favors the incidence of pest organisms (Paap *et al*., 2017).

CONCLUSIONS

The urban woodland of the city of Pinar del Río is made up of 13 forest species belonging to nine botanical families and 12 genera. The most represented family is Meliaceae; while the "Hermanos Cruz" distribution presents a greater abundance of forest species.

The species of urban trees serve as hosts to 21 harmful organisms that include eight causal agents of parasitic diseases, three orders, 11 families and 13 species of phytophagous insects, with a greater representation of Hemiptera and Lepidoptera.

Harmful organisms show a greater presence in the forest species *Callophylum antillanum, Grevillea robusta, Acasia mangium, Hibiscus elatus, Gmelina arborea, Tectona grandis* and *Eucaliptus sp*.

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