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Article

Insectos y ácaros fitófagos del arbolado en el Parque Recreativo y Cultural Tezozómoc, Azcapotzalco, Ciudad de México

Phytophagous mites and insects in the Recreational and Cultural *Tezozómoc* park trees, *Azcapotzalco*, Mexico City

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Resumen

Los árboles urbanos y suburbanos son elementos esenciales en las zonas pobladas, ya que tienen la capacidad de transformar las ciudades al aportar beneficios ambientales, estéticos, culturales y económicos. En la Ciudad de México, el parque Tezozómoc es muy importante para los habitantes de la zona norte por tener integrado un lago central artificial rodeado de abundante vegetación. Sin embargo, su arbolado ha presentado daños por diferentes agentes causales, por lo que en este estudio se detectaron y determinaron los insectos y ácaros fitófagos. Para el diagnóstico se muestreó 10 % de la frecuencia total de las especies dominantes de árboles y arbustos, mientras que para las especies de hospederas de poca frecuencia se consideró el total de los individuos. Los daños causados por los organismos fueron: clorosis, agallas o cecidias, defoliación, daños en floema y corteza. La obtención se realizó mediante colecta directa en frascos viales con alcohol al 70 %. La mayoría de los ejemplares colectados fueron insectos y ácaros chupadores de savia; el daño secundario asociado a ellos fue la formación de fumaginas. La especie arbórea más susceptible a plagas fue *Salix bonplandiana*, con 10 especies de fitófagos que representaron 19 % del total encontrado sobre los árboles del parque. Se registran por primera vez la avispa Eulophidae y a la formadora de agallas Aphelinidae en *S. bonplandiana*, el bruquido *Specularius impressithorax* y el barrenador de semilla en *Erythrina coralloides*.

Palabras clave: Agallas, arbolado urbano, defoliadores, descortezadores, insectos fitófagos, *Salix bonplandiana* Kunth.

Abstract

Urban and suburban trees are essential elements in the character of populated areas as they have the capacity to transform cities, providing environmental, aesthetic, cultural and economic benefits. In Mexico City, *Tezozomoc* Park is very important for the neighbors in the northern area because it has an artificial central lake surrounded by abundant vegetation. However, its trees have been damaged by different, which led to in this study, in which phytophagous insects and mites were detected and determined. For the diagnosis, 10 % of the total frequency of the dominant tree and shrub species was sampled, while the total of the individuals was considered for the low frequency host species. The damages caused by the organisms were: chlorosis, gills or cecidia, defoliation, damage to phloem and bark. Samples were obtained by direct collection in vials with 70 % alcohol. Most of the specimens collected were insects and sap sucking mites; the secondary damage associated with them was the formation of fumagins. The tree species most susceptible to pests was *Salix bonplandiana*, with 10 species of phytophagous that represented 19 % of the total found on the trees in the park. Derived from this study, the Eulophidae wasp and gill-forming aphelinidae in *S. bonplandiana*, the *Specularius impressithorax* bruch and the seed borer in *Erythrina coralloides* are recorded for the first time.

Key words: Galls, urban trees, defoliating insects, bark beetles, phytophagous insects, *Salix bonplandiana* Kunth.

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Introduction

Plant species face different types of selective pressures of a biotic and abiotic nature during their growth and development. The first type highlights the damage caused by phytophagous and pathogens; among abiotic factors, deficiencies in the nutritional quality of the soil, water, microclimatic conditions, pH and light (Azcon, 1993), which leads to the mechanical or physiological deterioration of trees, such as deformations, decreased growth , weakening or even death, with the consequent ecological, economic and social impact (Semarnat, 2002).

Of the five major orders of insects derive the majority of those that feed on plants (Coleoptera, Lepidoptera, Himenoptera, Diptera and Hemiptera). These arthropods are considered the first and most important consumers of vegetables in terrestrial systems, and together with mites, outnumber herbivorous vertebrates (Daly *et al*., 1998).

Any phytophagous population, whether plague or not, is influenced by the abiotic (physical and chemical) and biological environment that surrounds it: climate, water, soil, plants, other pests, natural enemies and alterations that produce cultural practices, as well as pesticide applications. The alterations that occur in such components usually have an impact on the levels reached by pest populations (Cisneros, 2010).

Foliage is the predominant photosynthetic part of plants, so their absence from pests, for example, results in the loss of the photosynthetic area and a reduction in the production of carbohydrates (Resh and Cardé, 2003). In the case of urban green areas, this behavior is particularly important due to the vital functions that this vegetation exerts: regulation of the microclimate, balance and control of environmental problems, landscape architecture, habitat of different species of fauna, recreation and recreation (González and García, 2007). Therefore, it is important to know the entomofauna that affects urban trees, due to the benefits it brings. In this context, the objective of this study was to identify insects and phytophagous mites, as well as their effect with the physical state of the trees of the *Tezozomoc* Cultural and Recreational Park (PCyRT), *Azcapotzalco*, Mexico City.

Materials and Methods

Location and description of the study area

The *Tezozómoc* Cultural and Recreational Park (PCyRT) was designed in 1978 by the architect Mario Schjetman de Garduño, and opened on March 21, 1982 as a cultural-recreational space, in a densely populated area in the northwest of Mexico City, where there are few green areas. The purpose of this project was to recreate the topography-orography of the Valley of Mexico and its five lakes from the end of the 15^{th} century, to offer through an cultural tour an historical and ecological vision in an easy and attractive way (Reséndiz *et al*., 2015).

The PCyRT is located northwest of the *Azcapotzalco* City Hall in Mexico City; its coordinates are 19°29’05” N and 99°12’38” West, at 2 250 meters above sea level (Figure 1). It covers an area of 270 000 m^2 (González and Moctezuma, 1999-2000). It borders to the north with the *Tlalnepantla* municipality, to the west with the municipality *Naucalpan*, to the south with the *Cuauhtémoc* and *Miguel Hidalgo* mayoralties and to the East with that of *Gustavo A. Madero*.

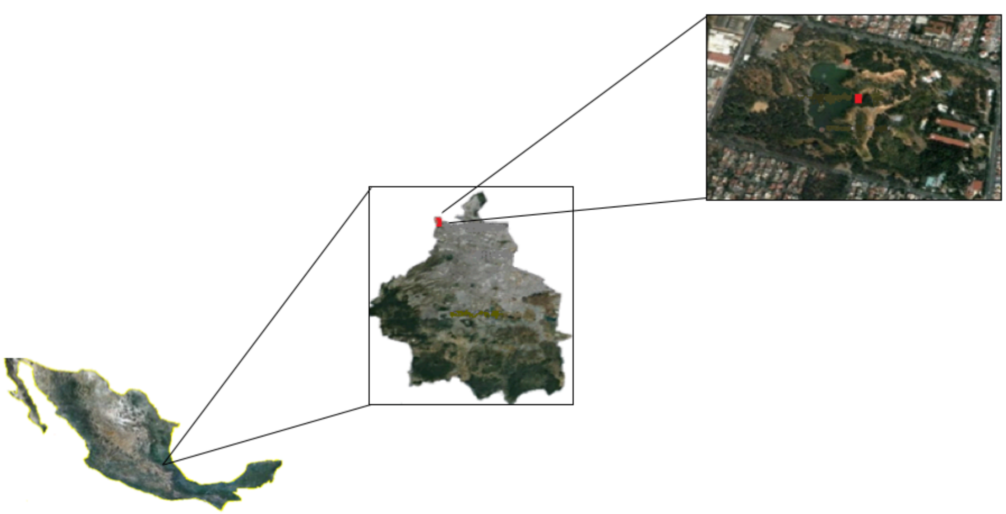


Figure 1. Location of *Tezozómoc* Recreational and Cultural Park.

According to the *Azcapotzalco* weather station, the climate corresponds to type C (w_0), subhumid temperate with rains in summer, of medium humidity, according to the Köeppen classification modified by García (Cuaderno Estadístico Delegacional, 2000).

At present, the soils in the *Tezozómoc* Park are sanitary landfills composed mainly of rubble and various garbage materials, so given its anthropic influence this type of soil is known as Androsol.

The flora of the park is represented by the following species, some of which are present in other major urban parks such as *San Juan de Aragón* (González *et al.,* 2014): eucalyptus (*Eucalytus globulus* Labill.; *E. camaldulensis* Dehnh*)*, ash (*Fraxinus uhdei* (Wenz.) Lingelsh*)*, white poplar (*Populus alba* L.), *jacaranda* (*Jacaranda mimosifolia* D. Don), peach (*Prunus persica* (L.) Stokes), Mexican hawthorne (*Crataegus mexicana* DC.), avocado (*Persea americana* Mill.), Chinese orange blossom (*Pittosporum tobira (*Thunb.) A. T. Aiton), laurel rose (*Nerium oleander* L.), scarlet firethorn (*Pyracantha coccinea* M. Roem*.*), orchid tree (*Bauhinia variegata* L.), *Montezumae* cypress (*Taxodium mucronatum* Ten.), *ahuejote* (*Salix bonplandiana* Kunth), loquat (*Eriobotrya japonica (*Thunb.) Lindl*.*), ficus (*Ficus microcarpa* L. F*.; Ficus benjamina* L*.*), *casuarina* (*Casuarina equisetifolia* L.), weeping willow (*Salix babylonica* L.), flame coral tree (*Erythrina coralloides* DC*.*), privet (*Ligustrum lucidum* A. T. Aiton; *Ligustrum japonicum* Thunb.), cedar (*Cupressus sempervirens* L.), cypress (*Cupressus lusitanica* Mill.), Peruvian peppertree (*Schinus molle* L*.*), radiata pine (*Pinus radiata* D. Don), flagship pine (*Pinus radiata* var. *binata* (Engelm.) Lemmon), Mexican pinyon (*Pinus cembroides* Zucc.), palm (*Phoenix canariensis* Hort ex Chabaud.), *yuca* (*Yucca guatemalensis* Baker.) and rubber tree (*Ficus elastica* Roxb. ex Hornem*.*), trembling poplar (*Populus tremuloides* Michx.), swamp wattle (*Acacia retinodes* Schltdl*.)*, wild black cherry (*Prunus serotine* Ehrn. ssp. *Capuli* (Cav.) Mc Vaugh), oak (*Quercus acutifolia* Née) and *yucca* (*Yucca elephantipes* Regel ex Trel.).

Field work

In order to know the general state of the study area, a preliminary tour was initially made in the *Tezozomoc* park with the help of a map provided by its administration. The different areas of the park were recognized, as well as their distribution and the type of aggregation of the trees; subsequently, a census of August 2009-2010 was carried out. From the botanical samples collected, the trees were identified based on the work of Rodríguez and Cohen (2003) and Martínez and Tenorio (2008). Pine samples were taken to the Forest Entomology and Phytopathology Laboratory of *Cenid Comef* from the *Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias (INIFAP).*

Entomological material collection. The health status assessment considered 10 % of the most frequent species from the census carried out; of the less frequent species, all the individuals were included. Samples of leaves, branches, fruits and bark were taken; the technique of beating and direct collection was applied, as well as a tray with 70 % alcohol. The plant material was placed in plastic bags to prevent desiccation and insects collected in the field were stored in vial tubes with 70 % alcohol, immature forms, such as nymphs, larvae or pupae that were found at the time sampling was collected and kept in breeding chambers (boxes) with part of plant material in the case of nymphs and larvae, in order to obtain the adult phases; this procedure was carried out in the Pest Control Laboratory of the *Facultad de Estudios Superiores Iztacala* (*Iztacala* Graduate Studies School) where it was finally identified.

Laboratory work

Determination of pines. Cones, bark and needle samples were taken. Cross-sections were made of the latter and placed on slides to observe the arrangement and number of the channels in the optical microscope (Carl Zeiss Axiostar Plus) and contrast them with the keys of Farjon *et al*. (1997) and Martínez (1948).

Entomological determination. The collected insects were observed under a stereoscopic Carl Zeiss Stemi 2000-C microscope and photographs were taken with a Canon Power Shot A640® camera. The taxonomic determination was made at the family, genus and species level through the support of the taxonomic keys of Ferris (1938), Peterson (1973), Stehr (1987), Blackman and Easton (1994, 2006), Halbert (2001), Triplehorn *et al.* (2005), Bautista (2006) and Unruh and Gullan (2008).

The assemblies were made according to the characteristics and size of the organisms: the dry assembly was carried out using entomological pins (bed bugs and beetles), as well as by specialized techniques in slides with Canadian balm (aphids and scales). In the case of mites, direct assembly with Hoyer's liquid was used (Remaudière, 1992; Solís, 1993; Triplehorn *et al.,* 2005).

Statistical analysis

To process the data obtained from the mite and insect samples, the relative frequency (F) was used, which is considered as the number of times in which a species appears recorded at least once and is expressed as a percentage (Dix, 1961), whose formula is:

$$F = \left({}^{mi}/_{M}\right)100$$

Where:

mi= Number of sampes where one species appeared in the total number of samples (*M*).

To determine whether there is independence between the sanitary condition (insects and mites) and the physical state of the crown and the tree trunk, a χ^2 test was used with the following formula:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\left(\frac{Oij - Eij}{Eij}\right)^2$$

Where:

Σi=1…r (sum of the number of populations or rows of the contingency table)

Σj=1…c (sum of categories or columns of the contingency table)

Oij = Observed frequency per cell

Eij = Expected frequency per cell

The criteria used to determine the percentage of damage are based on the following categories: minimum (0 to 25 %), significant (26 to 50 %), Severe (51 to 75 %) and very severe (76 to 100 %) (Benavides, 1996).

The hypotheses raised were the following:

Null hypothesis (Ho): the presence of insects or mites are independent of the physical condition of the trees.

Alternative hypothesis (Ha): the presence of insects or mites if it is dependent on the physical condition of the trees.

According to Durán *et al.* (2005), the decision rule was applied to reject the null hypothesis (Ho): χ20> χ2α, (r-1) (c-1).

Results and Discussion

Tree composition

According to the census, in the *Tezozómoc* Park there are 3 758 trees made up of 30 species that are grouped into 16 botanical families, of which 15 are native and 15 exotic. Regarding the permanence of the foliage, it was observed that 67 % (20) are evergreen and 33 % (10) are deciduous (Table 1).

Table 1. Listado de especies arbóreas en las que se ubicó a los fitopatógenos del parque Tezozomoc.

Species	Family	Number of trees
Eucalyptus camaldulensis Dehnh.	Myrtaceae	1 142
Populus tremuloides Michx.	Salicaceae	680
Schinus molle L.	Anarcardiaceae	380
Pinus radiata var. *binata* (Engelm.) Lemmon	Pinaceae	370
Cupressus lusitanica Mill.	Cupresaceae	214
Erythrina coralloides DC.	Fabaceae	175
Fraxinus uhdei (Wenz.) Lingelsh.	Oleaceae	150
Total		3 111

Determination of insects and mites

The phytophagous entomofauna and acarofauna grouped into 45 species included in 34 genera, 18 families and 6 orders (Table 2). The main eating habits of organisms are suckers (76 %) (Figure 2), which may be a consequence of the most abundant families being Aphididae (20 %), followed by Tetranychidae (13 %) (Figure 3); while, in the hosts the one that presented more phytophagous species was *Salix bonplandiana* (11), followed by *Populus tremuloides* (6) and *Acacia retinodes* (5) (Figure 4).

Table 2. Phytofagous mites and insects collected in each tree species.

Tree species	Order	Family	Species	Common name	Damaged structure	Damage kind	Frequency (%)
			Entomofauna				
Cupressus lusitanica Mill.	Coleoptera	Curculionidae	*Phloeosinus baumanni* Hopkins	Bark beetle	Trunk	Debarking	10.15
	Hemiptera	Aphididae	*Cinara* Curtis	Fleam		Sucker	
Pinus cembroides Zucc.	Hemiptera	Diaspididae	*Chionaspis* Signoret	Pine sclae	Foliage	Sucker	29.63
Pinus radiata D.Don	Hemiptera	Diaspididae		Pine sclae	Foliage	Sucker	100
	Hemiptera	Aphididae	*Eulachnus rileyi* Williams	Fleam		Sucker	
Pinus radiata var. *binata* (Engelm.) Lemmon	Hemiptera	Diaspididae		Pine sclae	Foliage	Sucker	41.34
	Coleoptera	Curculionidae		Bark beetle	Trunk	Debarking	6.61
Populus tremuloides Michx.	Hemiptera	Cicadellidae	*Empoasca* Walsh	Little cicada	Foliage	Sucker	45.00
			Alebra Fieber	Little cicada	Foliage	Sucker	45.45
		Tingidae	*Corythucha salicata* Gibson	Lace bug	Foliage	Sucker	20
		Aphididae	*Pemphigus populitransversus* Riley	Fleam	Petiole	Gill-forming	1.51
			Chaitophorus Koch	Fleam	Foliage	Sucker	3.8
	Diptera			Minelayer	Foliage	Minelayer (chewer)	13.64
Salix bonplandiana Kunth	Hemiptera	Cicadellidae	*Alebra* Fieber	Little cicada	Foliage	Sucker	95
		Tingidae	*Corythucha salicata* Gibson	Lace bug	Foliage	Sucker	20
		Aphididae	*Macrosiphum californicus* Baker	Fleam	Foliage (new buds)	Sucker	25
			Cavariella pustula Essig	Fleam	Foliage	Sucker	25
			Pterocomma smithiae Monell	Red fleam	Branches	Sucker	35
	Hymenoptera	Eulophidae o Aphelinidae		Wasp	Foliage	Gill-forming	65

	Lepidoptera	Gracillariidae	*Phyllocnistis* Zeller	Minelayer	Foliage	Minelayer (chewer)	75
		Geometridae		Caterpillar	Foliage	Defoliador	5
	Hemiptera	Largidae	*Stenomacra marginella* Herrich-schaeffer	Red bug	Foliage	Sucker	15
	Prostigmata	Eriophydae	*Aculops tetanothrix* Nalepa	Eriophid	Foliage	Gill-forming	95
		Tetranychidae		Tetraniquid	Foliage	Sucker	40
Salix babylonica L.	Prostigmata	Tetranychidae	*Eotetranychus lewisi* McGregor	Tetraniquid	Foliage	Sucker	26.31
	Hemiptera	Aphididae	*Pterocomma smithiae* Monell	Fleam	Branches	Sucker	15.8
			Chaitophorus pusilus Hottes and Frison	Fleam	Foliage	Sucker	10.53
		Largidae	*Stenomacra marginella* Herrich-schaeffer	Red bug	Foliage	Sucker	10.53
Schinus molle L.	Lepidoptera	Arctiidae	*Lophocampa* Harris	Tussok moth	Foliage	Defoliation	2.41
	Hemiptera	Psyllidae	*Calophya rubra* Blanchard	Psyllid	Foliage	Gill-forming	100
Eucalyptus globulus Labill.	Hemiptera	Psyllidae	*Ctenarytaina eucalypti* Maskell	Psyllid	Foliage (new buds)	Sucker	100
Eucalyptus camaldulensis Dehnh.	Hemiptera	Largidae	*Stenomacra marginella* Herrich-schaeffer	Red bug	Foliage	Sucker	4.2
		Psyllidae	*Blastopsylla occidentalis* Taylor	Psyllid	Foliage	Sucker	34.45
			Glycaspis brimblecombei Moore	Red gum lerp psyllid	Foliage	Sucker	100
Acacia retinodes Schltdl.	Prostigmata	Tetranychidae		Mite	Foliage	Sucker	83.67
	Hemiptera	Aleyrodidae		White little fly	Foliage	Sucker	14.29
		Monophlebidae	*Icerya* Douglas	Scale	Branches	Sucker	2.04
		Aphididae	*Macrosiphum* Linnaeus	Fleam	Fruit (pods)	Sucker	2.04
		Diaspididae	*Aspidiotus* Bouche	Scale	Foliage	Sucker	83.67
Erythrina coralloides DC.	Coleoptera	Bruchidae	*Specularius impressithorax* Pic	Bean weevil	Fruit (pods)	Carpofagous (borer)	5
	Prostigmata	Tetranychidae		Mite	Foliage	Sucker	20

	Hemíptera	Coccidae	*Toumeyella erythrinae* Kondo and Williams	Scale	Branches (females), Foliage (males).	Sucker	100
Ligustrum japonicum Thunb.	Hemiptera	Largidae	*Stenomacra marginella* Herrich-schaeffer	Red bug	Foliage	Sucker	100
Ficus benjamina L.	Hemiptera	Cicadellidae	*Empoasca* Walsh	Little cicada	Foliage	Sucker	23.3
			Alebra Fieber	Little cicada	Foliage	Sucker	23.3
		Aphididae	*Greenidea ficicola* Takahashi	Fleam	Foliage	Sucker	3.3
Fraxinus uhdei (Wenz.) Lingelsh.	Hemiptera	Miridae	*Tropidosteptes chapingoensis* Carvalho	Ash tree bug	Foliage	Sucker	100
	Prostigmata	Tetranychidae	*Olygonichus punicae* Hirst	Mite	Foliage	Sucker	34.28
		Eriophydae	*Aceria fraxiniflora* Felt	Eriophid	Flower	Gill-forming	7.14
Prunus serotina subsp. *Capulli* (Cav. ex Sreng.) McVaugh	Lepidoptera	Arctiidae	*Lophocampa* Harris	Tussok moth	Foliage	Defoliation	
Persea americana Mill.	Hemiptera	Aleyrodidae		White little fly	Foliage	Sucker	
		Aethalionidae	*Aethalion subquadratum* Saussure	Avocado green fly	Branches	Sucker	
			Hoplophorion monograma Germar	Avocado *periquitos*	Branches	Sucker	
	Prostigmata	Tetranychidae	*Olygonychus persea* Tuttle, Baker and Abbatiello	Mite	Foliage	Sucker	
Quercus acutifolia Née	Prostigmata	Tetranychidae		Mite	Foliage	Sucker	
	Hemiptera	Aleyrodidae		White little fly	Foliage	Sucker	

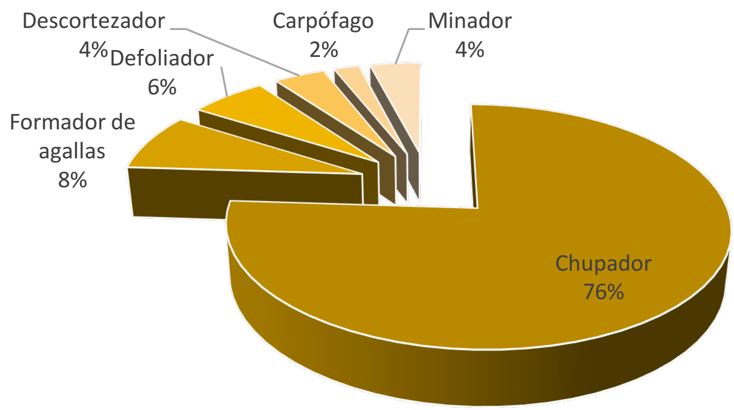


Figure 2. Percentage of damage caused by the phytophagus entomofauna (960 trees = 100 %).

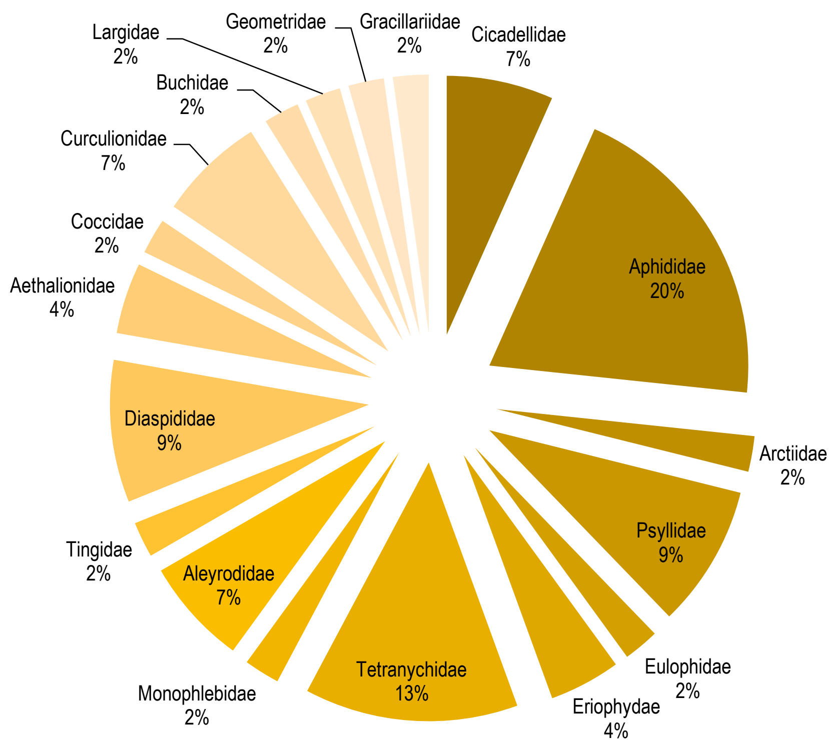
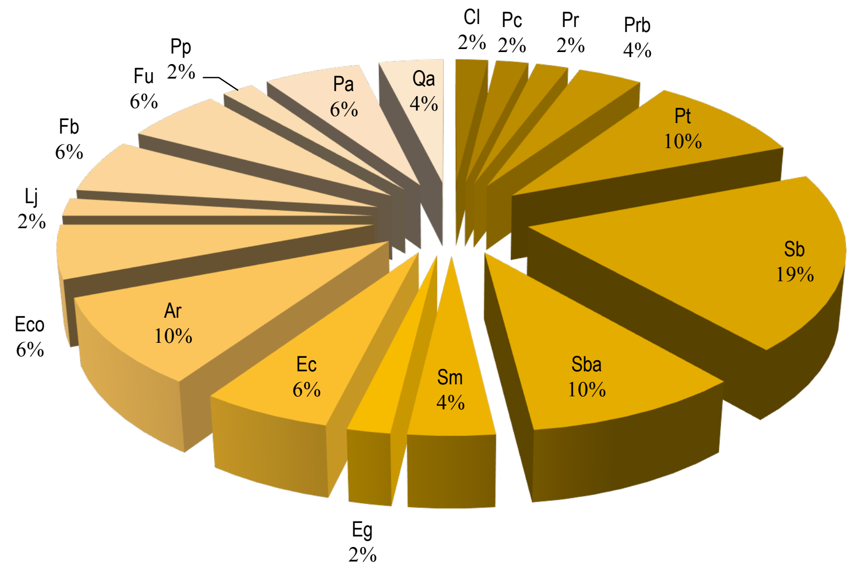


Figure 3. Species found on trees grouped by family.



Sb = *Salix bonplandiana;* Sba = *Salix babylonia;* Sm = *Schinus molle;* Eg = *Eucalyptus globulus;* Ec = *Eucalyptus camaldulensis;* Ar = *Acacia retinodes;* Eco = *Erythrina coralloides;* Lj = *Ligustrum japonicum;* Fb = *Ficus benjamina;* Fu = *Fraxinus uhdei;* Pp = *Pinus patula;* Pa = *Persea Americana;* Qa = *Quercus acutifolia;* Cl = *Cupressus lusitanica;* Pc = *Pinus cembroides;* Pr = *Pinus radiate;* Prb = *Pinus radiata* var. *binate*; Pt = *Populus tremuloides*.

Figure 4. Percentage of hosts affected by insects and mites.

The most frequent symptoms in the hosts were chlorosis or chlorotic points in the foliage, since the pathogens feed on the vascular tissue, mainly of the phloem, which causes the cells to collapse and block the passage of nutrients, in severe infestations cause premature fall of the foliage, in addition to the fact that most of these species produce honeydew (Cibrián *et al.,* 1995), (with the exception of mites) on which they develop fumagins, which are non-parasitic fungi, but live entirely of the honeydew produced by these insects, forming a dark and dense layer that reduces the amount of light that reaches the surface of the plant (Agrios, 2008). This fumagina was most evident in *Erythrina coralloides* caused by *Toumeyella erythrinae* Kondo and Williams in all trees (100 %).

Despite the observed frequency of *Aspidiotus* sp. (83.67 %) in *Acacia retinodes*, the percentage of damage could not be determined, because this host showed other problems such as a micromycete and abiotic factors, so it could not be defined which factor is affecting its health condition. However, the damage caused by *Icerya* sp. was minimal (0-25 %), because it sucks the sap in the branches and its frequency was minimal (2.04 %) for this host.

Although *Stenomacra marginella*, *Alebra* sp. and *Empoasca* sp. were frequent, had no significant effects (0-25 %) on their hosts (*Ligustrum japonicum* (100 %), *Ficus benjamina* (23 %) and *Populus tremuloides* (45 %); the above can be explained as they are polyphagous, that is, they feed on different plant species: The opposite occurred in *Salix bonplandiana* in which the damage was severe (51-75 %) since it presented chlorotic points on the leaf caused by a set of Tetraniquid species: *S. marginella* (95 %), *Alebra* sp. (95 %), *Empoasca* sp. (95 %) and *Corythucha salicata* (20 %); the latter was also observed in *Populus tremuloides* (20 %), with minimal damage (0-25 %).

On the other hand, the incidence of diaspidids (possibly of the *Chinaseis* genus) in *Pinus radiata* (100 %), *P. cembroides* (29.6 %), *P. radiata* var. *binata* (41.3 %) was minimal (0-25 %), which may be related to the fact that low density was recorded in all these species. The presence of *Tropidosteptes chapingoensis* Carvalho (100 %) was significant (26-50 %) in adult trees, and severe damage (51 to 75 %) was observed in young trees with a leaf yellowing, and chlorotic stippling, - characteristic symptom of this species- and foliage shed by 50 %. However, these expressions may be associated with different biotic factors such as other phytophagous insects and even abiotic factors such as air or soil pollutants.

The damage caused by aphids was very low (0-25 %) in the hosts *Cupressus lusitanica* (1 %), *Pinus radiata* (1 %), *Acacia retinodes* (2.04 %), *Populus tremuloides* (3.8 %), *Ficus* *benjamina* (3.3 %). In *Salix bonplandiana* (25 % and 35 %) it was significant (26-50 %) because it presented three different species of the Aphididae family.

The effects associated with the Tetranychidae family in their hosts (*Erythrina coralloides* (20 %), *Fraxinus uhdei* (34.28 %) and *Salix babylonica* (26.3 %) were minimal (0-25 %), as were the damages caused by *Blastopsylla occidentalis* Taylor (34.45 %) found in *Eucalyptus camaldulensis*, since in both cases not many organisms were found per host.

About the mites and insects forming gills or cecidia, *Aculops tetanothrix* Nalepa, 1889 is consigned, which causes the leaves to form a hard red structure that surrounds the mites; gills cause the leaves to bend and be shorter than those not infested, which favors their premature fall (Cibrián *et al.,* 1995). This behavior is consistent with what was observed in the field in the *Salix bonplandiana* host in which the frequency was 100 %; in the same way, gills that were not red were recognized. The same symptoms produced by *Aculops tetanothrix* were identified in *Schinus molle* (100 %), but were caused by the psyllid *Calophya rubra* Blanchard, 1852 (100 %), with damage of 51 to 75 %, but without a severe infestation.

Organisms belonging to the Eulophidae or Aphelinidae family (65%) were found in some gills, since according to Triplehorn *et al.* (2005), there is no great anatomical difference between these families, so it was difficult to define the family to which this wasp belongs; both have been reported as parasitoids, and there are no records on wasps of them mthat form gills in *Salix bonplandiana*. However, there are data on wasps belonging to the Eulophidae family, which are gill-forming in *Ophelimus eucalypti* Gahan, 1922 (species native to Australia) and in Chile in *Eucalyptus* spp. (Gómez *et al*., 2006). The damage caused by these two phytophages in *Salix bonplandiana* was very severe (76-100 %). Another species belonging to this family is *Quadrastichus erythrinae* Kim, 2004, recorded in different species of *Eritrina* in Taiwan (Yang *et al.,* 2004).

Among the mites and insects that make gills, the aphid is characterized by forming them in the petiole; therefore, the passage of water and nutrients to the leaves is partially interrupted, which leads to yellowing and premature fall of the foliage. In *Populus tremuloides* the damage by this organism was minimal (0-25 %) since its frequency was low (1.51 %). But, because it is a deciduous species, it causes the early loss of foliage and the presence of gills in the leaves that have fallen.

The erryphid Acerya fraxinoflora (7.14 %) is a newly reported mite for *Fraxinus uhdei* (Otero *et al.,* 1999), which has caused significant damage (26-50 %) as it affects flower buds and manifests itself with deformation of the inflorescence in the form of gills and abortion of flowers. García (1981) described that the formation of these gills or cecidia resulted from the continuous stimulation of the invading organism, which uses the gill as a means to develop.

A genus of lepidoptera was also identified among defoliator insects: *Lophocampa* sp. on *Schinus molle* (2.41 %) and on *Prunus serotina* subsp. *capulli*. This lepidopter caused minimal damage (0-25 %) in its hosts, probably because they are more specific, since they are primary parasites that attack vigorous trees, and not individuals in a state of physiological deficiency (Dajoz, 2001). This is not the main cause of defoliators having less frequency in the park, since they play an important role in food chains by transforming plant biomass into animal biomass and serving as food for numerous predators such as birds, which in the park are abundant (Martínez and Leyva, 2014).

Another type of common damage is that caused by mining insects, which are characterized by forming a mine, path, channels or streamers in the leaflet since it feeds mainly on the leaf mesophyll and causes it to yellow (Méndez *et al.,* 2008).

Two miners were registered in the park, an undetermined diptera in *Populus tremuloides* (13.64 %) and a lepidoptera of the Gracillariidae family, possibly of the genus *Phyllocnistis* sp., in *Salix bonplandiana* (75 %). They were counted at the rate of three dipterans per leaflet, while the microlepidopteros only one per leaflet. The damage caused by these insects was 26 to 50 %. Collected dipterans were found dead inside the mine without traces of parasitoids, possibly due to the plant itself or to endophytic fungi (Cornell and Hawkins, 1995), which can be explained because the defense chemicals are concentrated in the cuticle and in the cuticle. epidermis of the leaves.

In relation to the trunk, bark insects were less frequent, since they are only present when the trees are weakened by other factors, which, in extreme cases, results in the death of trees (Wood, 1982). Two species belonging to the Curculionidae family were found, one (*Dentrictonus adjuntus* Blanford, 1897) on *Pinus radiata* var. *binata* (6.61 %) and *Phloeosinus baumanni* Hopkins, 1905 in *Cupressus lusitanica* (10.15 %); in both species they caused severe damage (51 to 75 %). These barkers are characterized by feeding on the tissues of the vascular cambium and the inner bark of the trees.

Cibrián *et al.* (1995) indicates that *Phloeosinus baumanni* is not a primary pest for urban trees, but it becomes infested when it is weakened or in decline; they also mentioned that in *Valle de México* it is common to observe it on old trees of *Cupressus benthamii* and *C lindleyi*; however, these author do not specify location of plagued areas in the region nor percentage of damage.

NOM-019-SEMARNAT-2006 establishes that in Mexico there are bark insects of the *Dendroctonus, Ips, Phloesinus* and *Scolytus* genera, among others. Several of its species have an economic impact, to the extent that they are recognized as the most harmful forest pests in the country (Semarnat, 2012). Of the genera mentioned in the norm, *Phloesinus* spp. was detected in this study. on the trees of *Cupressus lusitanica.*

Another type of damage that was infrequent and less representative in terms of the number of species corresponds to carpal ghosts of *Specularius impressithorax* (Pic), which affected only 5 % of the individuals of *Erythrina coralloides*. This bruquido feeds on the seeds of the color; its distribution in Mexico and the severity of its damage are unknown, since it is a poorly reported species (Romero *et al*., 2009).

Table 3. Results of χ^2 and significance observed in the comparison of the health and physical state of the crown.

Species	χ^2	Observed significance
Cupressus lusitánica Mill.	21.387	8.747E-05
Pinus cembroides Zucc.	12.5	0.019
Pinus radiata D.Don	22	2.727E-06
Pinus radiata var. *binata* (Engelm.) Lemmon	93.472	5.043E-21
Pinus patula Schiede ex Schltdl. & Cham.	30	4.320E-08
Populus tremuloides Michx.	142.216	1.258E-30
Salix babylonica L.	10.363	0.0012
Salix bonplandiana Kunth	31.544	1.414E-07
Acacia retinodes Schltdl.	0.196	0.658
Erythrina coralloides DC.	3.243	0.072
Eucalyptus camaldulensis Dehnh.	15.827	0.0004
Eucalyptus globulus Labill.	10	0.0015
Schinus molle L.	6.666	0.0098
Fraxinus uhdei (Wenz.) Lingelsh	92	1.053E-20
Prunus pérsica (L.) Stokes	12	0.00053
Ligustrum japonicum Thunb.	8	0.0046
Ficus benjamina L.	60	9.485E-15
Yucca elephantipes Regel ex Trel.	56	7.247E-14

Table 4. Results of χ^2 and significance observed in the comparison of the health and physical state of the trunk.

Species	χ^2	Observed significance
Cupressus lusitánica Mill.	74.746	5.700E-17
Pinus radiata var. binata (Engelm.) Lemmon	19.599	2.050E-04
Schinus molle L.	58.032	2.578E-14
Populus tremuloides Michx.	240.711	6.679E-52
Salix babylonica L.	22.166	1.537E-05
Salix bonplandiana Kunth	3.243	0.071
Acacia retinodes Schtdl.	67.618	1.381E-14
Erythrina coralloides DC.	40	2.539E-10
Eucalyptus camaldulensis Dehnh.	238	2.084E-52
Ficus benjamina L.	3.158	0.075

The value of α was 0.05; when the observed significance was greater, the null hypothesis (Ho) was accepted; in *Acacia retinodes* and *Erythrina coralloides* this hypothesis was accepted (Table 2), which means that the physical state of the crown is independent of the presence of insects and mites. In the case of the first species, other factors were observed that could influence their condition, such as exposed roots, because 16 % of the trees did not show foliage; while in *E. coralloides* the damage caused by the phytophagous did not influence the physical state of the leaves.

On the other hand, the physical condition of the crown of *Cupressus lusitanica, Pinus cembroides, P. radiata* var. *binata, P. radiata, P. patula, Populus tremuloides, Salix babylonica, S. bonplandiana, Eucalyptus camaldulensis, E. globulus, Fraxinus uhdei, Prunus persica, Ligustrum japonicum, Schinus molle, Ficus benjamina* and *Yucca elephantipes* was affected by the presence of those entomological agents.

In *P. radiata* var. *binata, C. lusitanica, E. camaldulensis, S. molle, P. tremuloides, S. babylonica, S. bonplandiana, A. retinodes* and *E. coralloides,* dependence was confirmed between the presence of bark beetles and the physical condition of the trunk.

The debarkers of *P. radiata* var. *binata* and *C. lusitanica* caused mechanical damage to the trunk; in *S. molle, P. tremuloides, S. babylonica, S. bonplandiana, A. retinodes, E. coralloides* and *E. camaldulensis* no debarking was found.

Conclusions

The trees and shrubs determined in this park comprised 30 species, of which half were native and the other half exotic. The mostly used for reforestation were four: *Eucalyptus camaldulensis, Populus tremuloides*, *Schinus molle* and *Pinus radiata* var. *binata*, which suggests little tree diversity.

When assessing the relationship of the sanitary condition and the physical state of the crown and trunk, it was concluded that in most of the hosts the damages were due to the action of insects and phytophagous mites, while *Salix bonplandiana* was the most susceptible tree species to pests with 10 species of insects and mites, which represented 19 % of the total phytophagous entomofauna found in the park. The Eulophidae or Aphelinidae gill-forming wasp in *S. bonplandiana* and the existence in the park of *Specularius impressithorax* as seed borer of *Erythrina coralloides* are considereded new reports.

Conflict of interests

The authors declare no conflict of interests.

Contribution by author

José Francisco Reséndiz Martínez: field work and writing of the manuscript; Lidia Guzmán Díaz: establishment of sites and sampling of the entomological material; Ana Lilia Muñoz Viveros: phytophagous insect and mite taxonomic identification, review and correction of the manuscript; Lilia Patricia Olvera Coronel: preparation of the entomological material, review and correction of the manuscript; Ma. de Lourdes Pacheco Hernández: review and correction of the manuscript; Victor Javier Arriola Padilla: general review and correction of the manuscript.

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