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SURVEYING AND DOCUMENTING OF THE CULTIVATED PLANTS AND EVALUATION OF AIR POLLUTION IN HISTORICAL GARDENS IN ALEXANDRIA, EGYPT (B) ANTONIADIS GARDEN

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ABSTRACT: Second only to Cairo in terms of population and density, Alexandria is one of Egypt's major cities. It has been one of the major metropolises in the ancient world in terms of culture, intellect, politics, and economy from its founding in the late third century BC. Since the Ptolemaic era, Alexandria's elegant urban environment has always been reflected in the building of gardens and public areas for its citizens. The collection of the garden profiles is divided into two sets. The main one includes historical context, archaeological installations, and a summary of the key features that define this park. The second group consists of a survey of the garden-cultivated plants. Numerous plant species, including trees, shrubs, climbers, palms, and succulents, can be found in the garden. These categories are comprised of 132 species, 103 genera, and 45 families. Due to their old age and consequently low numbers in Alexandria, the plant groups cultivated in the Antoniadis garden have a high value. There are some plant groupings in the garden, but there aren't enough of them there to fill out the groups and restore the area's wonder and splendour. The air pollution tolerance index (APTI) was determined for various plants grown in the garden because it is situated in the middle of Alexandria (Semouha zone), which denotes that it is situated in a region with medium-density traffic.

Keywords: Antoniadis garden, archaeological installations, cultivated plant groups, air pollution tolerance index (APTI).

INTRODUCTION

Alexandria, Egypt's second-largest city after Cairo, has over the years shown itself to be just as significant as the country's capital. According to the UN's 2013 State of the World's Cities report, Alexandria's urban agglomeration population growth rate has consistently outpaced Cairo's since 1990 through to both cities' anticipated rates in 2025 (Abdou Aziz, 2004). It's also important to note that Cairo was the capital of Egypt from the Ptolemaic period (Bell, 1927), which began in 331 BC until the Arab conquest in 641 AD. After its founding in the 300s BC, it quickly rose to become the largest metropolis in the ancient world in terms of culture, intelligence, politics, and economy. In terms of cultural backgrounds, Alexandria is regarded as Egypt's most multiethnic and culturally varied city. This is frequently linked to the Mediterranean as well as the globalisation, exposure, and integration that made Alexandria a reachable and livable city for people of many nations and ethnicities. This also applies to the names of the Alexandrian neighbourhoods, such as "Bacus" (Bacchus) in Greek, "Soter" in Ptolemaic, "San Stefano" in Roman/Coptic, "Shatby" in Arabic, "Semouha" in Jewish, "Stanley" in modern European, and "Moustafa Kamel" in modern Egyptian (Saad El-Din *et al.,* 1993).

Since its foundation within the Ptolemaic period, Alexandria has always exhibited a cultured urban environment throughout the variously rich eras that have intercommunicate town the top quality of the urban environment in Alexandria was emphasized by creating gardens and public spaces for the community since the Ptolemaic era (300 BC). There were many gardens; for the Alexandrians shared the Egyptian love for flowers, and also the flower-sellers and sellers of garlands were a familiar sight within the streets (Bell, 1927). This example of the ancient gardens in Alexandria since the Ptolemaic era is El-Nozha, Antoniadis, Rose and Alex Zoo Gardens Complex. This complex comprises a group of gardens located east of Alexandria city along the Mahmoudiyah Canal, still standing to our present day, making it one of the foremost ancient gardens in Egypt and the Middle East (Ilbert, 1996; Hamdy, 2010).

The gardens of a city with such a rich history as Alexandria serve as living archives. These important sites are vulnerable to negative alteration and degradation if they are uncovered and neglected, among other difficulties due to land use demands. Many of Alexandria's gardens date back to the 19th and 20th centuries and are designed with numerous nods to this period's cultural character (Abd El-Aziz, 2012).

The purpose of this study is to provide a historical account of the garden, as well as documentation of the cultivated plants, and division of the garden's contents into a botanical group comprised of 132 species that belong to 103 genera and 45 families. The air pollution tolerance index (APTI) was determined for various plants cultivated in the garden because it is located in the middle of Alexandria, which suggests that it is situated in a medium-density traffic region.

MATERIALS AND METHODS

History and location:

Antoniadis garden, which occupies the location of the Royal Palace gardens from the Greco-Roman era in Semouha neighborhood, is regarded as Alexandria's third-largest public park. Sir John Antoniadis established Antoniadis garden in 1860. It was created as a private garden for his mansion, which is designated as a historic monument with the number 1250 in the governorate conservation registry of Alexandria, and was created by French architect Paul Richard. With a total area of around 45 feddans, the palace and its park were built as miniature replicas of the Versailles palace and grounds in Paris. Sir John Antoniadis's son Antonis donated the castle, the grounds, and all of the building materials in 1918.

Antoniadis garden is located in Semouha area in the site of the Royal Palace gardens of the Graeco-Roman era, and it is considered the third largest public park in Alexandria. Antoniadis garden was founded 1860 by sir John Antoniadis and designed by the French architect Paul Richard to be a private garden for his palace which is listed as a historic monument numbered 1250 in the governorate conservation registry of Alexandria. Both the palace and its park were constructed as a miniature version of the palace and gardens of Versailles in Paris with a total area of about 45 feddans. In 1918, Antonis Antoniadis, the son of Sir John Antoniadis, donated the palace and garden as well as all the components of Al-Nozha complex to Alexandria town council as was his father will. In March, 1986 the presidential decree number 112/1986 moved the palace and garden of Antoniadis to be under the full authority of the Ministry of Agriculture till this moment. During the Arab-Israeli war of 1967, the Egyptian government deducted about 14 feddans from the garden to be used for military purposes. In July 2004, the governor of Alexandria donated the palace of Antoniadis and about two feddans of gardens surrounding the palace to the project of Bibliotheca Alexandrina to be maintained and exhibited by the library as a part of Sir John Antoniadis collection, which didn't happen till moment (Hamdy, 2010 and Arafa, 2014).

Antoniadis garden is quite unique in terms of historical gardens in Egypt (Fig., 1).

Surveying and documenting of the cultivated plants:

Field trips were carried out to collect the studied species from Antoniadis garden in Alexandria, Egypt during the two successive seasons of 2020 and 2021. A total of 132 species represented 103 genera and 45 families were collected. The recorded genera were arranged alphabetically within their families. Data collections for investigation and identification criteria of the studied taxa were based on the flora and taxonomic references (Bailey, 1947; Tackholm, 1974; Boulos, 1999, 2000, 2002 and 2005). The author collected about 76 specimens from the studied area. The plant collections were prepared as herbarium sheets.

Available information such as area, year of establishment, species composition and landmarks for the garden were obtained from several sources. Historical documents, photos, personal contact with authorities and researchers as well as travelers' books. Recent data including maps, photos and satellite images, for the gardens, have been downloaded using the Google Earth Software, it is hoped that the appended plant list of the floristic composition of Antoniadis garden is significant for any future studies in conserving National Gardens (El-Torky *et al.*, 2013).

Air Pollution Tolerance Index (APTI):

1. Sampling:

Plants were randomly selected from the garden. Leaf samples of the various plants were then collected. Three replicates of fully matured leaves were immediately taken to the laboratory for analysis. The plants selected for the present study were available at the site. After washing, the leaf fresh weight was taken immediately upon getting to the laboratory. Samples were preserved in the refrigerator for other analyses.

2. Relative water content of leaves (RWC):

Using the method described by Singh *et al*. (1997), leaf relative water content was determined and calculated with the formula

$$RWC = (FW - DW) / (TW - DW) \times 100$$

FW = fresh weight

Fig. 1. Map showing the location of Antoniadis garden in Alexandria City.

DW = dry weight

TW = turgid weight

Fresh weight was obtained by weighing the fresh leaves. The leaves were then immersed in water for 24h, blotted dry and then weighed to get the turgid weight. The leaves were then dried over-night in an oven at 70 ºC and reweighed to obtain the dry weight.

3. Total chlorophyll content:

According to the method of Moran (1982) as follows:

A half gram of fresh leaves was extracted by 10 ml of N,N, dimethyl formamide for 24-48 hours. In a dark place, the temperature was kept at 4 °C until all pigments were extracted. One ml was taken from this mixture and then completed with N,N, dimethyl formamide to 10 ml. The absorbance of the extracts was measured at a wavelength of 660 nm for chlorophyll A, 640 nm. for chlorophyll B using spectrophotometer. The total chlorophyll content was calculated as mg/g fresh weight. The equations for the determination of the concentrations of chlorophyll A, chlorophyll B and chlorophyll A+B were:

Chlorophyll A (ml/l) =

$$(9.784 \times E.\ 660) - (0.99 \times E.\ 640)$$

Chlorophyll B (ml/l) =

$$(21.426 \times E.\ 640) - (4.65 \times E.\ 660)$$

Chlorophyll A+B (ml/l) =

$$(5.134 \times E.\ 660) + (20.436 \times E.\ 640)$$

4. Leaf extract pH:

Five grams of the fresh leaves were homogenized in 10 ml of deionised water. This was filtered and the pH of the leaf extract was determined after calibrating the pH meter with a buffer solution of pH 4 and 9.

5. Ascorbic Acid (AA):

Ascorbic acid content (expressed in mg/g) was measured using spectrophotometric method (Bajaj and Kaur, 1981). In this regard 1.0 g of the fresh foliage was put in a test-tube, 4.0 ml oxalic acid – EDTA extracting solution was added; then 1.0 ml of orthophosphoric acid and 1.0 ml 5% tetra oxosulphate acid were added to this mixture, 2.0 ml of ammonium molybdate was added followed by 3.0 ml of water. The solution was then allowed to stand for 15 minutes, after which the absorbance at 760 nm was measured with a spectrophotometer. The concentration of ascorbic acid in the sample was then extrapolated from a standard ascorbic acid curve.

6. APTI determination:

This was done following the method of Singh and Rao, (1983). The formula of APTI is given as:

APTI = A (T+P) + R/10

Where:

A= ascorbic acid (mg/g dry wt.)

T= total Chlorophyll (mg/g dry wt.)

P= pH of leaf extract.

R= relative water content of leaf tissue (%).

The Entire sum was divided by 10 to obtain a small manageable figure.

7. APTI range:

APTI was categorized according to Kalyani and Singaracharya, 1995 as following:

APTI < 1 = very sensitive

1 to 16 = sensitive

17 to 29 = intermediate

30 to 100 = tolerant

This method expresses the capacity of a plant to battle against air pollution.

Statistical analysis:

Statistical analysis of the studied species was based on excel program to calculate the following criteria: (1) Number and ratios of species per each family, (2) Number and ratios of genera per each family (climbers,

palms, perennials, shrubs, succulents and trees).

The layout of the experiment was a randomized complete block design (RCBD) which contained 3 treatments with three replicates. Data were subjected to analysis of variance (ANOVA) using the SAS program (SAS Institute, 2002). The Means of the individual factors and their interactions were compared by L.S.D test at 5% level of probability according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

The garden profiles were gathered in the form of two sets. The first one consists of the archaeological installations including historical background, and a snapshot of the important elements that define this park. The second set consists of the plant surveying cultivated in the garden. This garden was selected according to their historical significance for the Egyptian gardens as well as the availability of reliable data describing the nature of their landscape characteristics. In addition to calculating the air pollution tolerance index (APTI) for garden plants.

1. Archaeological installations:

a. The palace:

The palace was built in the nineteenth century. In its beginning, the palace was a villa in the middle of the gardens, until Khedive Tawfiq visited it and issued a high decree to convert it into a palace.

The palace consists of two floors and includes many rooms in addition to the basement and service rooms built on its roof. During the reign of King first Fouad, the lower floor was designated as reception halls and a dining hall, as well as the office and the library. As for the upper floor, it was divided into two sleeping suites. The first wing included a sleeping place for the king and the other for the queen, in the middle of them was a hall to eat breakfast, and there was a separate room for changing clothes in each place. On the tribal side, this wing also includes four rooms for the princesses through which one can see the statue of "Venus", which was fixed in one of his hands, a reflecting mirror that reflects the sunlight at sunrise to illuminate the princesses' rooms. As for the other wing, it is dedicated to sleeping guests. It adorned the corners of the front facade. The roof of the palace has four marble statues representing the four seasons. The palace overlooks from the north side the front garden through a large terrace from which a large part of the gardens and the royal greenhouse are seen. The palace also overlooks from the southern side through its terrace on the garden (tea garden) the palace has an entrance from the south side, its sides adorned with two lions made of pure alabaster (Ramadan, 1993 and Youssef, 2009), (Fig., 2).

b. Royal greenhouse:

The royal greenhouse is located at the western end of Antoniadis park. It was used to breed imported plants that grow in climatic conditions different from the Egyptian climate, such as tropical plants and plants of hot regions, as the greenhouse building is large in size and built in the form of a wrought iron gable consisting of three parts. The front and back are square in shape, rising to several levels and ending with a square upper dome. The middle part extends to connect the front and rear parts, and all sides and ceilings are covered with glass as well as wooden slats with the intention of shading. The greenhouse also contains six entrances. The four side entrances are similar in shape, while the two middle entrances are opposite and in the middle of the greenhouse (Ramadan, 1993 and Youssef, 2009) (Fig., 3).

c. Alabaster statues groups:

In the garden there is a distinguished group of beautiful, elaborate and rare full-size marble statues purchased from Italy, numbering up to seventeen statues of mythical and historical figures and some of the world's great dignitaries of the great explorers, including Venus, the goddess of beauty, holding a large mirror reflecting the

Fig. 2. A photograph showing Antoniadis palace inside Antoniadis garden.

Fig. 3. A photograph showing the royal greenhouse of Antoniadis garden.

sun rays in the morning towards the southern windows of the palace. There are also statues representing the four seasons, in addition to lions made of alabaster. It also includes rare statues of many world historical figures, including (Christopher Columbus, Admiral Nelson, Magellan, Vsko di Gama) (Youssef, 2009 and Abd El-Rahman 2017), (Fig., 4).

2. Plant surveying:

The garden area is about 45 feddans, divided into two main parts (the first part: the garden geometric style, the second part: the garden natural style). The garden contains some plant groups, but it lacks a lot of plants to complete the groups in the garden and to restore the beauty and splendour of the historic garden (Youssef, 2009 and SIS, 2014), (Fig., 5).

The garden contains many plant groups such as trees, shrubs, climbers, palms and succulents. These groups belong to 45 families, 103 genera and 132 species. The plant groups planted in the Antoniadis garden are of high value due to the high age and the few numbers in Alexandria city, for example, *Coccoloba pubescens, Enterolobium timbova, Syzygium cumini, Ficus religiosa*, *Ficus macrophylla, Dracaena draco, Schotia brachypetala* and *Ficus benghalensis* (Abd El-Wahed, 1988; Heneidy, 2010; SIS, 2014), (Fig., 6).

The number of cultivated species in Antoniadis garden representing which species have survived and what changes have occurred during the last decades, provide the basis for examining the long-term efficiency and effectiveness of planting and management plans. Data presented in Table (1) show the recorded cultivated perennial species during this study (Khalifa and Loutfy, 2006; Heneidy, 2010).

Data presented in Table (2), showed that, the most common families were Arecaceae which contains 16 genera with 15.533% of the total genera in the garden, followed by family Fabaceae which contains 12 genera with 11.650%, followed by family Malvaceae which contains 6 genera with 5.825%, followed by family Apocynaceae which contains 5 genera with 4.854%, followed by families Bignoniaceae**,** Myrtaceae and Rosaceae which contain 4 genus with 3.883%, followed by families Euphorbiaceae and Verbenaceae which contain 3 genus with 2.912%, followed by families Agavaceae, Araliaceae, Asparagaceae, Cupressaceae, Meliaceae, Moraceae, Oleaceae, polygonaceae, Rutaceae and Solanaceae which contain 2 genus with 1.941%, followed by families Acanthaceae, Anacardiaceae, Araucariaceae, Asteraceae, Berberidaceae, Boraginaceae, Caricaceae, Casuarinaceae, Combretaceae,

Fig. 4. Photographs showing the twelve statues in Antoniadis garden, (A) Venus statue, (B) Vskodigama, (C) Magellan, (D) Christopher Columbus, (E) Admiral Nelson, (F-M) unknown statues.

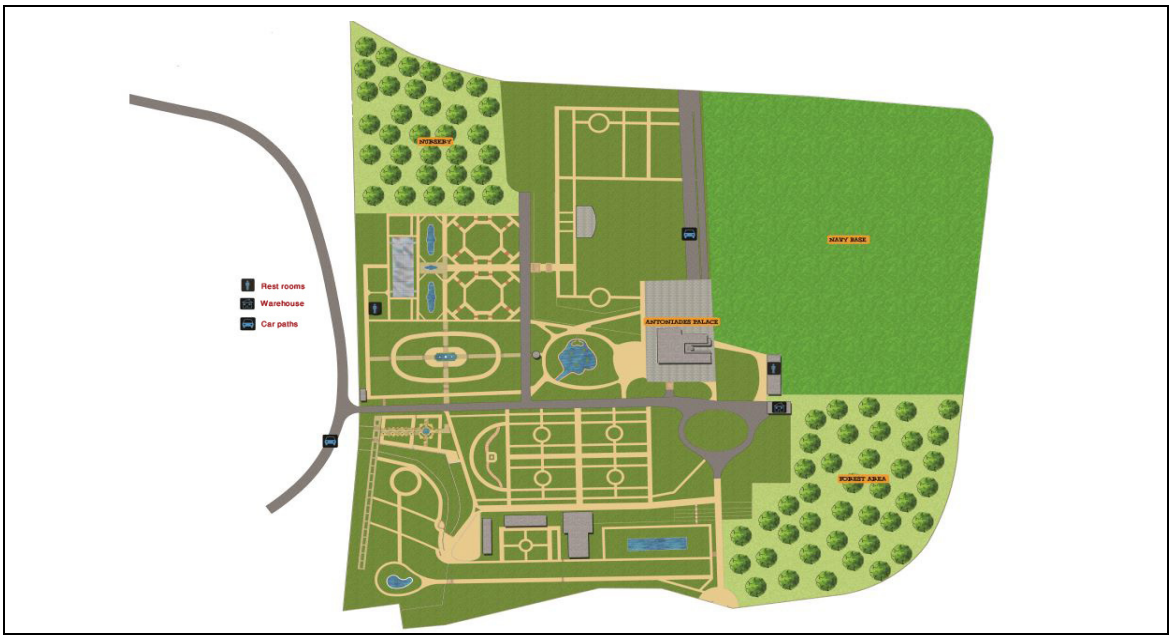

Fig. 5. Antoniadis garden parts.

Fig. 6. *Coccoloba pubescens* L. (1), *Cycas revoluta* Thunb. (2), *Delonix regia* (Bojer ex Hook.) Raf. (3), *Schotia brachypetala* Sond. (4), *Dracaena draco* L. (5), *Cassia fistula* L. (6).

Table 1. List of presence of plant families, genera, species, and numbers in the Antoniadis garden in the season of 2020.

Family	Botanical name	Arabic name
Acanthaceae	*Adhatoda yasica* L.	بستاشيا بيضاء
Agavaceae	*Agave americana* L.	الأجاف الأمريكى
	Agave sisalana Perr.	الأجاف السيسال
	Yucca alaifolia L.	يوكا خضراء
Anacardiaceae	*Schinus molle* L.	فلفل رفيع الأوراق
	Schinus terebinthifolius Raddi.	فلفل عريض الأوراق
Apocynaceae	*Acokanthera spectabilis* (Hochst) Codd.	أكوكنثرا
	Carissa macrocarpa (Eckl.) A.DC.	كريسا
	Nerium oleander L.	دفلة
	Plumeria frangipani L.	ياسمين هندى
	Thevetia peruviana (L.) Lippold	تفيتيا صفراء
Araliaceae	*Oreopanax reticulatum* Hort, Decne & Planch.	آراليا سوداء
	Schefflera actinophylla (Endl.) Lowry & G.M. Plunkett	آراليا عادية
	Schefflera arboricola (Hayata) Merr.	شفليرا
Araucariaceae	*Araucaria bidwillii*	أروكاريا بدويليای
	Araucaria heterophylla Salisb.	أروكاريا عيد الميلاد
Arecaceae	*Archontophoenix alexandrae*	أرشنتوفونكس (نخلة الأمير)
	Areca vestiaria Giseke	اريكا حمراء
	Brahea armata S. Watson	براهيا بيضاء
	Chamaerops humilis L.	كميروبس
	Dypsis lutescens (H.Wendl.) Beentje & J. Dransf.	آريكا صفراء
	Elaeis guineensis Jacq.	نخيل الزيت
	Howea forsteriana Becc.	كنتيا
	Hyphaene thebaica L.	نخيل الدوم
	Livistona chinensis (Jacq.) R.Br. *ex* Mart.	لاتانيا (ليفستونيا)
	Phoenix canariensis Chabaud	فيونكس كناری (نخيل كناری)
	Phoenix dactylifera L.	نخيل بلح
	Phoenix robellinii O'Brien	فونكس روبللينى
	Ptychosperma elegans (R.Br.) Blume	سيفورسيا
	Rhapis excelsa (Thunb.) A.Henry	رابس
	Roystonia regia (HBK) Cook	نخيل ملوكى
	Sabal palmetto (walter) Lodd.	نخيل السابال
	Syagrus romanzoffianum (Cham.) Glassman	كوكس
	Washingtonia filifera L.(Lind.) ex Andre. H. Wendi.	واشنجتونيا مجوز
	Washingtonia robusta H.A. Wendi.	واشنجتونيا مفرد

Continued

Table 1. Continued.

Family	Botanical name	Arabic name
Asparagaceae	*Beaucarnea recurvata* Lem.	زلوعة (دراسينا قلة)
	Dracaena draco L.	دراسينا دراكو
	Dracaena fragrans (L.) Ker Gawl. (Santa Rosa)	دراسينا سانتاروزا
	Dracaena marginata	دراسينا مارجناتا
	Dracaena reflexa Lam.	دراسينا رفليكسا
Asteraceae	*Gazania rigens* (L.) Gaertn.	جازانيا
Berberidaceae	*Nndina domestica* Thunb.	ناندين
Bignoniaceae	*Jacaranda acutifolia* D. Don.	جكراندا
	Kigelia pinnata Jacq.	أبو النجف (مشطورة)
	Spathodea campanulata P. Beauv.	اسباثوديا
	Tecoma stans (L.) Juss. ex Kunth	تيكوما صفراء
Boraginaceae	*Cordia myxa* L.	مخيط
Caricaceae	*Carica papaya* L.	باباظ
Casuarinaceae	*Casuarina hybrida*	كازورينا
Combretaceae	*Conocarpus lancifolius* Engl.	كونو كاربس
Cupressaceae	*Cupressus macrocarpa* Hartw. ex Gordon.	سرو ليمون
	Cupressus sempervirens L.	سرو عادى
	Platycladus orientalis (L.) Franco	تويا
Cycadaceae	*Cycas revoluta* Thunb	سيكاس (ذيل الجمل)
Euphorbiaceae	*Acalypha wilkesiana* Muell. Arg.	أكاليفا
	Codieum variegatum (L.) A. Juss.	كروتن
	Jatropha curcas L.	جاتروفا (شجرة البترول)
Fabaceae	*Acacia farnesiana* (L.) Wight & Arn.	فتنة
	Acacia saligna (Labill.) H.L.Wendl.	أكاسيا سالجنا
	Albizzia julibrissin	اللبخ الأحمر
	Albizzia lebbeck L.	لبخ (ذقن الباشا)
	Baubinia purpurea L.	بوهينيا بنفسجى (خف الجمل)
	Cassia fistula L.	خيار شمبر
	Cassia nodosa L.	كاسيا ندوزا
	Ceratonia siliqua L.	خروب
	Dalbergia sisso Roxb. ex DC.	سرسوع
	Delonix regia (Bojer ex Hook.) Raf.	بوانسيانا
	Enterolobium timbova Mart.	انترولوبيم
	Erythrina humeana Spreng.	أرثرينا
	Parkinsonia aculeate L.	باركنسونيا
	Schotia brachypetala Sond.	الخروب الأحمر
	Sophora japonica (L.) Schott	صافورا زرقاء

Continued

Table 1. Continued.

Family	Botanical name	Arabic name
Gramineae	*Cynodon dactylon* (L.) Pers.	نجيل بلدى
Lamiaceae	*Clerodendrum indica* L.	ياسمين زفر
Lythraceae	*Lagerstroemia indica* L.	تمر حنة أفرنجة
Magnoliaceae	*Magnolia grandiflora* L.	مانوليا
Malvaceae	*Bombax malabaricum* L.	بومباكس
	Brachichyton populneus (Schott & Endl.) R.Br.	أستركوليا
	Brachychiton discolor F. Muell	استركوليا (بودرة العفريت)
	Chorisia speciosa (A.St.-Hil.) Ravenna	كوريزيا بمبى
	Hibiscus rosa sinensis L.	هبسكس مفتوح
	Lagunaria patersonii (DC.) Rchb.	لاجوناريا
	Malvaviscus arborea Cav.	هبسكس بلحة (ملفافسكس)
Meliaceae	*Khaya senegalensis* (Desr.) A.	كايا (الماهوجنى الأفريقى)
	Melia azedaracht L.	زنزلخت
Moraceae	*Ficus aspera* Forst. F.	فيكس اسبيرا
	Ficus benghalensis L.	تين بنغالى
	Ficus benjamina L.	فيكس بنجامينا
	Ficus elastic Roxb. ex Hornem. var. *decora*	فيكس الاستيكا ديكورا (فيكس مطاط)
	Ficus laurifolia L.	فيكس لوريفوليا (منجاوى)
	Ficus lyrata Warb.	فيكس ليراتا (ماندولين)
	Ficus macrophylla Desf. ex Pers.	فيكس ماكروفيلا
	Ficus nitida L.	فيكس عادى
	Ficus pyriformis Hook. & Arn.	فيكس بيريفورمس (مثلثى)
	Ficus sycomorus L.	فيكس جميز
	Morus alba L.	توت أبيض
Myrtaceae	*Callistemon linearis* Schrad. & J.C. Wendl.	فرشاة الزجاج
	Eugenia uniflora L.	أيوجينا (الكريز البرازيلى)
	Myrtus communis L.	مرسين
	Syzygium cumini (L.) Skeels	بامبوزيا
Nyctaginaceae	*Bougainvillea glabra* Choisy	جهنمية
Oleaceae	*Ligustrum lucidum* W.T. Aiton	ليجسترم
	Olea europaea L.	زيتون
Pinaceae	*Pinus roxburghii* Sarg.	صنوبرطويل الأوراق
Pittosporaceae	*Pittosporum tobira* (Thunb.) W.T. Aiton	بتسبورم
Plumbaginaceae	*Plumbago capensis* Lam.	بلمباجو أبيض
	Plumbago auriculata Lam.	بلمباجو أزرق
Poaceae	*Bombusa vulgaris* Schrad. *ex* J.C. Wendl	بامبو (غاب)

Continued

Table 1. Continued.

Family	Botanical name	Arabic name
Polygonaceae	*Antigonon leptopus* Hook. & Arn. (white)	أنتيجونن أبيض (كراكولا)
	Coccoloba pubescens L.	كوكولوبا بوبسكينز
	Coccoloba uvifera L.	عنب البحر
Rhamnaceae	*Ziziphus spina-christi* (L.) Desf.	نبق (سدر)
Rosaceae	*Prunus armeniaca* L.	مشمش
	Pyrus calleryana Decne.	كمثرى برية
	Rhaphiolepis umbellate (Thunb.) Makino	رافوليبس
	Rosa hybrida	ورد بلدى
Rutaceae	*Casimiroa edulis* La Llave	كازميرو (السابوتا)
	Citrus aurantium L.	نارنج
Sapindaceae	*Dodonea viscosa* Jacq	دودونيا
Simanoubaceae	*Alianthus excels* Roxb.	شجرة السماء
Sterculiaceae	*Pterospermum acerifolium* (L.) Willd.	بتيروسبرما
Solanaceae	*Brugmansia arborea* (L.) Sweet	داتورة زينة
	Cestrum parqui L.'Hér.	سسترم أصفر (ملكة الليل)
Strelitziaceae	*Strelitzia alba* (L.f.) Skeels	أوجاستا (عصفور الجنة الكبير)
	Strelitzia reginae Ait.	عصفور الجنة الصغير
Tamaricaceae	*Tamarix nilotica* (Ehrenb.) Bunge	اتل- عبل
Verbenaceae	*Citharexylon quadrangularis*	سندروس
	Duranta plumeri L.	دورنتا خضراء
	Duranta plumeri variegata	دورنتا مبرقشة
	Lantana camara L.	لانتانا كمارا
	Lantana montevidensis (Spreng.) Briq.	لانتانا زرقاء
Zamiaceae	*Zamia furfuracea* L.f. in Ait.	زاميا ملعقية

Badr (2003, 2013, 2014) and Heneidy (2010)

Cycadaceae, Gramineae, Lamiaceae, Lythraceae, Magnoliaceae, Nyctaginaceae, Pinaceae, Pittosporaceae, Plumbaginaceae, Poaceae, Rhamnaceae, Sapindaceae, Simanoubaceae, Sterculiaceae, Strelitziaceae, Tamaricaceae and Zamiaceae which contain 1 genus with 0.970%, respectively.

Data presented in Table (2), showed that, The most common family was Arecaceae contains 19 species with 14.393% of the total species in the garden, followed by family Fabaceae contains 15 species with 11.363%, followed by family Moraceae contains 11 species with 8.333%, followed by families Malvaceae contains 7 species with 5.303%, followed by families Apocynaceae, Asparagaceae and Verbenaceae contains 5 species with 3.787%, followed by families Bignoniaceae, Myrtaceae and Rosaceae contains 4 species with 3.030%, followed by families Agavaceae, Araliaceae, Cupressaceae, Euphorbiaceae and Polygonaceae contains 3 species with 2.272%, followed by families Anacardiaceae, Araucariaceae, Meliaceae, Oleaceae, Plumbaginaceae, Rutaceae, Solanaceae and Strelitziaceae contains 2 species with 1.515%, followed by families Acanthaceae, Asteraceae, Berberidaceae, Boraginaceae, Caricaceae, Casuarinaceae, Combretaceae, Cycadaceae, Gramineae, Lamiaceae, Lythraceae, Magnoliaceae,

Table 2. Numbers of genera, species and their percentages in the Antoniadis garden in the season of 2020.

No.	Family	Genus		Species	
		No.	(%)	No.	(%)
1	**Acanthaceae**	1	0.970	1	0.757
2	**Agavaceae**	2	1.941	3	2.272
3	**Anacardiaceae**	1	0.970	2	1.515
4	**Apocynaceae**	5	4.854	5	3.787
5	**Araliaceae**	2	1.941	3	2.272
6	**Araucariaceae**	1	0.970	2	1.515
7	**Arecaceae**	16	15.533	19	14.393
8	**Asparagaceae**	2	1.941	5	3.787
9	**Asteraceae**	1	0.970	1	0.757
10	**Berberidaceae**	1	0.970	1	0.757
11	**Bignoniaceae**	4	3.883	4	3.030
12	**Boraginaceae**	1	0.970	1	0.757
13	**Caricaceae**	1	0.970	1	0.757
14	**Casuarinaceae**	1	0.970	1	0.757
15	**Combretaceae**	1	0.970	1	0.757
16	**Cupressaceae**	2	1.941	3	2.272
17	**Cycadaceae**	1	0.970	1	0.757
18	**Euphorbiaceae**	3	2.912	3	2.272
19	**Fabaceae**	12	11.650	15	11.363
20	**Gramineae**	1	0.970	1	0.757
21	**Lamiaceae**	1	0.970	1	0.757
22	**Lythraceae**	1	0.970	1	0.757
23	**Magnoliaceae**	1	0.970	1	0.757
24	**Malvaceae**	6	5.825	7	5.303
25	**Meliaceae**	2	1.941	2	1.515
26	**Moraceae**	2	1.941	11	8.333
27	**Myrtaceae**	4	3.883	4	3.030
28	**Nyctaginaceae**	1	0.970	1	0.757
29	**Oleaceae**	2	1.941	2	1.515
30	**Pinaceae**	1	0.970	1	0.757
31	**Pittosporaceae**	1	0.970	1	0.757
32	**Plumbaginaceae**	1	0.970	2	1.515
33	**Poaceae**	1	0.970	1	0.757
34	**Polygonaceae**	2	1.941	3	2.272
35	**Rhamnaceae**	1	0.970	1	0.757
36	**Rosaceae**	4	3.883	4	3.030
37	**Rutaceae**	2	1.941	2	1.515
38	**Sapindaceae**	1	0.970	1	0.757
39	**Simanoubaceae**	1	0.970	1	0.757
40	**Sterculiaceae**	1	0.970	1	0.757
41	**Solanaceae**	2	1.941	2	1.515
42	**Strelitziaceae**	1	0.970	2	1.515
43	**Tamaricaceae**	1	0.970	1	0.757
44	**Verbenaceae**	3	2.912	5	3.787
45	**Zamiaceae**	1	0.970	1	0.757

Nyctaginaceae, Pinaceae, Pittosporaceae, Poaceae, Rhamnaceae, Sapindaceae, Simanoubaceae, Sterculiaceae, Tamaricaceae and Zamiaceae contains 1 species with 0.757%, respectively.

3. Air pollution tolerance index (APTI):

The experimental site where the air pollution tolerance index (APTI) was evaluated provided the majority of the plants used in this investigation. The air pollution tolerance index (APTI) was calculated for 30 plant species growing in Antoniadis garden, and the findings are displayed in Table (3). The resistance and susceptibility of plant species can be determined using all biochemical parameters examined for APTI. Cell wall formation, photosynthetic carbon fixation, and cell division all depend on ascorbic acid (Klump *et al.,* 2001). (Singh *et al.,* 1997), Ascorbic acid productivity is also linked to total chlorophyll. Air pollution in urban and industrial regions can be adsorbed, absorbed, stored, or integrated into the plant body, causing harm in a variety of ways if hazardous. Injuries will be severe in sensitive plants and minor in tolerant ones. The sensitive species aid in the detection of air pollution, whereas the tolerant species aid in the reduction of air pollution (Flowers *et al.*, 2007). Planting tolerant species in polluted areas can have a positive impact on the environment since they act as pollution "sinks." Because of this, it could be required to assess how well plants tolerate air pollution. Four leaf parameters were used by Singh and Rao (1983) to produce an empirical value for the Air Pollution Tolerance Index, which measures the level of plant species' tolerance to air pollution (APTI). Table (3) made it evident that the plants' levels of susceptibility to air pollution varied. In order to select a particular plant species for each of the city's residential, commercial, and industrial areas, the current study aims to evaluate the air pollution tolerance index (APTI) of a number of plant species that are growing close to the city's residential, business, and industrial areas in order to suggest a particular plant species for each one (Kalyani and Singaracharya, 1995). Planting tolerant species in polluted areas can have a positive impact on the environment since they act as pollution "sinks". Because of this, it could be required to assess how well plants tolerate air pollution. Four leaf parameters were used by Singh and Rao (1983) to produce an empirical value for the Air Pollution Tolerance Index, which measures the level of plant species' tolerance to air pollution (APTI).

When exposed to a polluted environment, plant leaves may act as a persistent absorber; as a result, vegetation cleans the air naturally by absorbing gases and particulate matter through leaves. Sensitive plant species are suggested as bio-indicators (Tripathi *et al*., 1999; Raina and Sharma, 2006). Bio-indicators might be particularly useful because of their high sensitivity to a variety of factors (De-Temmerman *et al.,* 2004). Every plant part can be used as a biomonitor in a variety of ways, and different plant species behaved differently to various toxins (Mingorance *et al.,* 2007). Development of green belts (Shannigrahi *et al.,* 2004), adecrease of traffic noise (Pathak *et al.,* 2011), and pollution abatement at roadside sites and nearby industry the air have been utilized by Joshi and Swami (2007) and Krishnaveni *et al.* (2012), using the air pollution tolerance index together (APTI). The classification of plant species is done using the Singh and Rao, (1983) approach. By absorbing, adsorbing, detoxifying, accumulating, and/or metabolizing pollutants without suffering a significant loss in development, green plants serve as a sink and filter to reduce air pollution, which improves air quality by supplying oxygen to the environment. It may be hypothesised that plants that can endure higher pollutant concentrations operate as pollution scavengers because they are considered to be tolerant species.

CONCLUSION

Egypt gardens are barren, uncared for, degrading quickly, and even shrinking in

Table 3. The mean of air pollution tolerance index (APTI) of plant species in Antoniadis garden, Alexandria city in the two seasons of 2020 and 2021.

No.	Botanical name	A	T	pH	RWC	APTI	A	T	pH	RWC	APTI
				2020					2021		
Palms											
1.	***Chamaerops humilis* L.**	3.06	3.49	4.51	76.74	10.12	3.11	3.49	4.58	75.93	10.10
2.	***Phoenix canariensis* Hort. ex chabaud**	5.01	3.97	5.42	75.71	12.28	5.06	3.98	5.48	74.89	12.28
3.	***Phoenix dactylifera* L.**	5.25	4.03	5.58	72.42	12.29	5.31	4.06	5.65	71.62	12.32
4.	***Sabal palmetto* (walter) Lodd.**	3.01	3.69	4.75	75.80	10.12	3.06	3.69	4.82	75.01	10.10
5.	***Washingtonia robusta* H.A.wendi.**	4.39	4.15	6.28	73.64	11.94	4.45	4.15	6.35	72.83	11.95
Trees											
1.	***Thevetia nerifolia* (Pers.) K. Schum.**	3.98	3.10	7.41	54.62	9.65	4.03	3.09	7.49	53.81	9.65
2.	***Chorisia speciosa* A. St. Hil.**	2.01	1.54	6.42	80.60	9.66	2.05	1.54	6.48	79.81	9.62
3.	***Delonix regia* (Bojer) raf.**	2.29	4.60	6.94	72.60	9.91	2.40	4.61	7.01	71.79	9.96
4.	***Bauhinia purpurea* L.**	1.94	1.78	6.13	66.17	8.15	2.00	1.78	6.18	65.37	8.13
5.	***Cassia nodosa* L.**	2.61	4.37	6.01	52.40	7.95	2.66	4.38	6.08	51.56	7.93
6.	***Erythrina humeana* L.**	2.21	4.34	5.64	70.80	9.29	2.26	4.35	5.72	69.99	9.27
7.	***Ficus elastic Roxb. Ex Hornem. var.decora***	3.71	3.01	7.05	68.52	10.59	3.76	3.02	7.12	67.72	10.58
8.	***Ficus nitida* L.**	2.69	1.89	7.57	93.67	11.91	2.73	1.88	7.64	92.87	11.89
9.	***Ficus benghalensis* L.**	2.74	1.50	8.47	82.45	10.98	2.79	1.51	8.54	81.64	10.97
10.	***Ficus benjamina* L.**	2.90	2.14	7.24	78.60	10.58	2.96	2.15	7.31	77.79	10.58
11.	***Ficus lyrata* Warb.**	4.89	1.45	8.14	81.35	12.83	4.94	1.45	8.21	80.54	12.83
12.	***Ficus macrophylla* Desf ex pers.**	4.95	1.44	7.84	72.82	11.87	4.99	1.44	7.91	72.01	11.87
13.	***Ficus sycomorus* L.**	5.46	1.46	6.91	70.15	11.59	5.51	1.46	6.99	69.35	11.59
14.	***Albizzia lebbek* (L.) Benth.**	2.05	1.28	6.42	75.34	9.11	2.09	1.28	6.48	74.53	9.07
15.	***Schinus terebinthifolius* Raddi.**	3.83	2.46	6.84	83.41	11.90	3.88	2.46	6.91	82.62	11.90
Shrubs											
1.	***Acalypha wilkesiana* Muell.**	2.20	2.90	6.14	52.92	7.28	2.21	2.91	6.21	52.12	7.22
2.	***Acokanthera oblongifolia* (Hochst) Codd.**	3.83	2.80	7.41	62.60	10.17	3.88	2.81	7.48	61.79	10.18
3.	***Duranta plumeri* jacp.**	2.98	5.30	6.34	65.65	10.04	3.04	5.29	6.41	64.84	10.04
4.	***Hibiscus rosa sinensis***	3.99	4.15	6.49	53.64	9.61	4.05	4.16	6.57	52.83	9.62
5.	***Lantana camara* L.**	3.03	5.76	6.47	62.81	9.99	3.08	5.76	6.54	61.99	9.99
6.	***Malvaviscus arboreus* Cav.**	4.06	4.04	7.84	72.74	12.10	4.11	4.05	7.91	71.93	12.11
7.	***Nerium oleander* L.**	1.89	2.65	6.08	67.98	8.45	1.94	2.65	6.15	67.18	8.42
Perennials											
1.	***Gazania rigens* (L.) Gaertn.**	2.14	3.03	5.98	48.50	6.78	2.19	3.06	6.05	47.73	6.77
Climbers											
1.	***Bougainvillea glabra* choisy ex DC.**	3.93	6.31	7.05	41.15	9.37	3.99	6.32	7.12	40.34	9.39
2.	***Plumbago auriculata* Lam.**	2.86	5.39	6.43	53.05	8.69	2.90	5.39	6.48	52.25	8.67
L.S.D. at 0.05		0.023	0.017	0.016	0.023	0.071	0.036	0.018	0.020	0.018	0.063

A: ascorbic acid (mg/g d.w); T: total chlorophyll (mg/g f.w); pH: leaf extract pH; RWC: relative water content (%)

size. Since many of these parks are historical landscapes, it is imperative that they are maintained in good shape. The biggest issue with such historically significant parks is that neither the municipality nor community members give them the required care and emphasis. In Egypt, there are no precise standards or procedures for identifying, classifying, or protecting such important open spaces. The rate of degradation of Alexandria's gardens was further accelerated by the absence of a methodical yet practical strategy. The Antoniadis garden's cultivated flora, archaeological installations, and any other historical landscapes should all be described in this study.

Continuous exposure to contaminants causes pollution to build up on plants and integrate into their own systems, changing the character of the leaf and making it more susceptible. A number of biochemical alterations are used to quantify this sensitivity before the air pollution tolerance index. All of the plants in our investigation were discovered to be tolerant and intermediate species.

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حصر وتوثيق النباتات المنزرعة وتقييم تلوث الهواء في الحدائق التاريخية في الإسكندرية، مصر (ب) حديقة أنطونيادس

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تعتبر الإسكندرية واحدة من أكبر المدن في مصر من حيث عدد السكان، وتأتي في المرتبة الثانية بعد القاهرة. منذ نشأتها في ٣٠٠ قبل الميلاد، كانت واحدة من أكبر المدن في العالم القديم، ثقافياً وفكرياً وسياسياً واقتصادياً. تنعكس بيئة الإسكندرية الحضرية الراقية على مدى العصور المختلفة دائماً في إنشاء الحدائق والأماكن العامة لسكانها منذ العصر البطلمي. تحتوى الحديقة على مجموعتين رئيسيين يتكون الجزء الأساسي من المنشآت الأثرية بما في ذلك الخلفية التاريخية، ولقطة للعناصر المهمة التي تحدد الخطوط العريضة لهذه الحديقة. المجموعة الثانية تتكون من المساحات النباتية المزروعة داخل الحديقة. تحتوي الحديقة على مجموعات نباتية عديدة مثل الأشجار والشجيرات والمتسلقات والنخيل والنباتات العصارية. تنتمي هذه المجموعات إلى ٤٥ عائلة و ١٠٣ أجناس و ١٣٢ نوعاً. تعتبر المجموعات النباتية المزروعة داخل حديقة أنطونيادس ذات قيمة عالية بفضل تقدمها في العمر وكذلك قلة الأعداد داخل مدينة الإسكندرية. تحتوي الحديقة على بعض المجموعات النباتية، لكنها تفتقر إلى الكثير من النباتات لإكمال المجموعات داخل الحديقة ولإستعادة روعة الحديقة التاريخية. بالإضافة إلى ذلك، نظراً لوجود الحديقة وسط الإسكندرية (منطقة سموحة)، مما يعني أنها تقع خلال منطقة مرورية متوسطة الكثافة، وبالتالي تم حساب مؤشر تحمل تلوث الهواء (APTI) للعديد من النباتات المزروعة داخل الحديقة.