Biodiversity Journal, 2022, 13 (1): 25–35 https://doi.org/10.31396/Biodiv.Jour.2022.13.1.25.35

Characterization of the biodiversity of ornamental flora in the urban perimeter of the city of Tlemcen (Northwest of Algeria)

Fatima Bendiouis[1], Rédda Aboura[1,*], Mustapha Ainad Tabet[1] & Fatiha Barka[1]

[1]Laboratory of Ecology and Management of Natural Ecosystems, BP119 Department of Ecology and Environment, Faculty of Sciences of Nature and Life, Earth and Universe Sciences, University of Tlemcen, 13000 Algeria
*Corresponding author, email: aredda78@yahoo.fr

ABSTRACT The objective of this study was to analyze and characterize the biodiversity of the ornamental flora in the urban perimeter of the region of Tlemcen (Northwest of Algeria) in the two public gardens chosen in the city of Tlemcen. By considering in this approach the various statistical indices of plant biodiversity that will allow us a better knowledge of the ecological potential of the environment to shelter a wide range of taxa adapted to the ecological conditions of the biotope considered. The results obtained showed a large number of species from a floristic richness point of view, including 86 ornamental species recorded in the 1[er] Juin garden (Grand Bassin) and 24 in the Boujlida garden. The biogeographical origin of the inventoried species at the level of the study stations revealed a considerable number of species of the non-Mediterranean type compared to the Mediterraneanone. The calculation of the different diversity indices confirms different outstanding representatives of the plant species within their taxonomic families. The Shannon index was the values obtained of 5.24 in the garden of 1[er] Juin compared to those of Boujlida with 3.72, which determined more interesting representativeness of the abundance of the species counted within their respective families in the first garden by contribution to the second. The Simpson index makes it possible to note greater representativeness of all the species within the Boujlida garden with a percentage of 50% compared to that of 1[er] Juin, which was only of the order of 30%. Finally, we can conclude that these two gardens offer an opportunity to develop the ornamental flora of the city of Tlemcen while trying to promote the introduction of native species for sustainable preservation to ensure the sustainability of these taxa.

KEY WORDS Tlemcen, garden; inventory; ornamental; taxonomy; biodiversity; preservation.

Received 12.09.2021; accepted 30.12.2021; published online 22.02.2022

INTRODUCTION

In urban areas, public green spaces constitute ecosystems that symbolize islets of nature and its plant and animal biodiversity represent an important pole for maintaining it (Clergeau, 1996); hence the social demand for nature in the city, which has become one of the fundamental elements of a better quality of life in these environments (Calenge, 1997; Mathieu, 2000). Therefore, the public garden becomes a key to the development of this area where it means “a naturalistic urban space, planted, landscaped and maintained by the community for the enjoyment of all” (Puiboube, 1996).

In fact, studies have shown that these public green spaces offer their users important ecosystem services including, air purification, climate regulation, moderation of extreme temperatures, and intellectual stimulation (Bolund & Hunhammar, 1999), but also and especially a positive impact on the sustainability of the urban landscape by improving the technical and acoustic characteristics of buildings, thus generating significant optimization of rainwater management and regulation of biodiversity (Daures, 2011). Many studies have focused on the study of the plant diversity of urban public green spaces, which revealed their importance throughout the world (Turner et al., 2005; Smith et al., 2006), hence the interest of our study on the city of Tlemcen. We noticed that few works have been conducted in this regard.

The objective of this study was to determine the floristic diversity of the inventoried ornamental plants and their biogeographical origins in two public green spaces, circumscribed within the urban perimeter of the city of Tlemcen (Northwest of Algeria).

It should be noted that administratively, the management and development of these two areas are the fate of the municipality of Tlemcen, one of which is historically older and above all protected and limited, located at a higher altitude compared to the second more recent, unprotected, and under the greater maritime influence because of its northern exposure without the presence of natural or artificial barriers. The different topography of these two spaces, the date of their creation, and the management of their maintenance, can they influence the floristic composition of the existing ornamental plants and their respective specific richness?

MATERIAL AND METHODS

Geographical location and climatic overview

The study perimeter which administratively forms part of the Wilaya of Tlemcen, geographically belongs to the Mediterranean region, to northern Africa, and the extreme west of Algeria, located between 34°40' and 35° 21' North latitudes and between 1°20 'and 2°30' West longitude.

The Wilaya of Tlemcen covers an area of 12,246 km², bordered to the north by the Mediterranean Sea, to the northeast by the Wilaya of Aïn-Temouchent, to the east by the Wilaya of Sidi Bel-Abbès, to the west by Morocco and to the south by the Wilaya of Naâma. The town or city of Tlemcen (34°53' N, 1°18' W) is the capital of the Wilaya which is highly urbanized, as it extends over an area of 40 km². Leaning against the side of the plateau of Lalla Setti (1025 m altitude) to the South, and Koudia (760 m altitude) to the North. Its two eastern and western ends merge with the commune of Mansourah and Chetouane by its urbanization (Fig. 1).

The Tlemcen region has been studied by several authors who have exhaustively defined the region's climate, notably Emberger (1930-1955), Bagnouls & Gaussen (1953), Chaumont & Paquin (1971), Alcaraz (1969-1982), Hadjadj-Aoul (1995), Ainad Tabet (1996), Benabadji & Bouazza (2000), Tabti

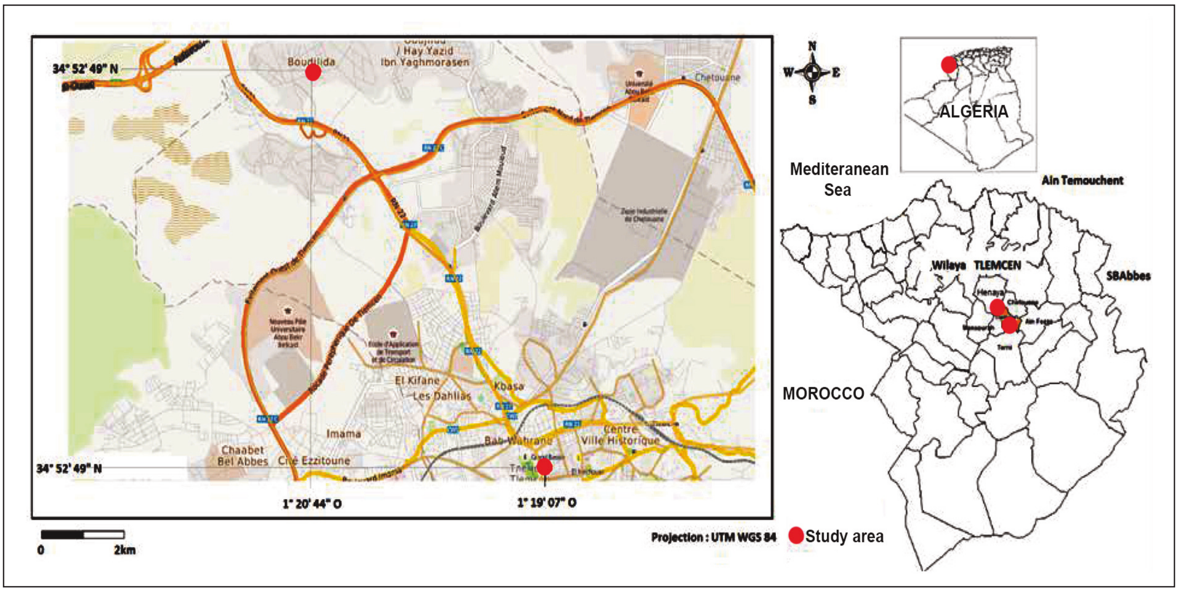

Figure 1. Geographical location of the two studied stations.

(2017) and Aboura & Siba (2018) to name just these works among many others.

The climate type is Mediterranean, characterized by a hot and dry season of varying length, which can span at least seven months, and another noticeably short, cold, and humid. One of the characteristics of this type of climate is the interannual irregularity of precipitation, where there are annual variations linked to the cycle of the period of humidity with that of drought, which is recognized to be the fundamental feature of the Mediterranean climate.

The seasonal regime of the study area is of the winter-autumn type (HAPE) whose maritime influence is pronounced with the first maximum of precipitation in winter, the second in autumn, and summer which remains the driest season. From the classification of climates from a temperature point of view (Debrach, 1953), the average thermal amplitude of this area corresponds to the semi-continental climate (25 ° C <Mm <35 ° C).

According to the bioclimatic synthesis defined by the Pluviothermal Quotient of Emberger (1952), the bioclimate of the study area corresponds to the semi-arid type with temperate winter.

Choice of stations and floristic inventory

The choice of two distant gardens was not fortuitous since the first is recognized to belong to the ancient city of Tlemcen called the 1er Juin public garden (Grand Bassin) at an altitude of 795 m; on the other hand, the second is in the new northern extension of the city called Garden of Boujlida at an altitude of 603 m.

The analysis of the floristic richness of these two study stations as well as their chorological characteristics would make it possible to highlight their floristic originality, their state of conservation, and therefore their heritage value (Fig. 2).

In such approaches, one proceeds to the method of exhaustive qualitative inventory of vegetation, which consists in counting, drawing up, and establishing a list of the existed species by traversing all the surface in question, where the identification of the taxa enumerated (between other those recognized as ornamental), their taxonomic families and their respective biogeographic types are the objective of the present study.

For this, we referred to the new flora of Algeria by Quézel & Santa (1962-1963) confirmed doubly by the work of the phylogenetic group of angiosperms (APG III, 2009) and the work of the conservatory and botanical garden of Genevaon North Africa (CJBG).

Fieldwork started in February 2019 and ended a year later (February 2020). Several field trips were organized during this period. Once the final list of the inventory was established, we tried to interpret the biogeographical character to define the origin of this flora and specially to distinguish the proportion

Figure 2. General view of the two studied stations (left: 1er Juin (Grand Bassin); right: Boujlida).

of Mediterranean from non-Mediterranean knowing that this method constitutes an essential basis for any attempt to conserve biodiversity (Quézel, 1991).

Assessment of floristic diversity

To be able to compare the diversity of the flora present and knowing that the diversity of the elements of a community is a quality that is immediately necessary to the analysis of the environment (Frontier & Pichod-Viale, 1993), relative indices to this method were used, including that of Shannon (H), Piélou's equitability (EH), that of Simpson (Is), Simpson's equitability (Es) and finally the index of Margalef (Dmg).

Shannon's index

Shannon's entropy H is one of the most used indices of diversity and has the advantage of considering the relative abundance of each species (Dajoz, 1982).

Walter in 1994 points out that abundance is the number of individuals present in a community. This diversity index is calculated using the following formula:

$$H = - \Sigma Pi \log_2 Pi$$

Pi: Relative abundance of each species and equal to Ni / N.

Ni: The abundance of species "i" and N the total number of species.

- H is zero when the sample contains only one species present and in this case the H diversity increases as the number of species increases.
- H reaches its maximum value ($H=\log_2 N$) when all species have the same abundance, so they are also represented in the sample.

The use of Shannon's formula H is only strictly valid when the sample whose diversity is to be measured is representative of a population that is theoretically infinite or at least large enough not to be changed by sampling.

- The Shannon index is often accompanied by the Piélou equitability index:

$E_H = H / Hmax$ where $Hmax = \log_2 S$

(S = total number of families).

The equitability index measures the distribution of individuals within species regardless of species richness. Its value varies from 0 to 1 including:

0: Dominance of individuals of a species.

1: Equi-distribution of individuals of species.

Simpson's index

This index allows the measurement of the effective number of very abundant individuals. The formula is as follows:

$$I_S = 1/ \Sigma Pi^2$$

The value of this index starts with 1 as the lowest possible number (community containing only one species), a higher value indicates greater diversity. The maximum value is the number of species in the sample.

- The Simpson's index is often accompanied by the equitability index noted as follows:

$$E_S = (I_S - 1) / (S - 1)$$

This index varies between 0 and 1:

- If $E_s = 0$, the differences in the abundance of individuals between each species are strong
- If $E_s = 1$, the differences in the abundance of individuals between each species are equal

Margalef's index

This index has the advantage of being simple to calculate, however, it can still prove to be sensitive to sampling effort (Magurran, 2004). It is less common in work related to diversity and is calculated using the following formula:

$$D_{mg} = (S - 1) / LnN$$

With two possible interpretations:

- $D_{mg} = 0$ when all the individuals belong to the same species.
- D_{mg} is maximum when each individual belongs to a different species (S = N).

RESULTS AND DISCUSSION

Floristic characterization
1er Juin Garden Station (Grand Bassin)

The public green space relating to the station of the 1er Juin garden counted 86 species belonging to over 48 families of which those best represented were Asteraceae such as *Bellis perennis* L., *Chrysanthemum carinatum* L. and *Anthemis arvensis* L. and Rosaceae such as *Rosa chinensis* L. and *Prunus armeniaca* L. which had a very ornamental vocation (6.98% for the two families). Arecaceae, Oleaceae, and Solanaceae have come next with 4.65% each (Table 1, Fig. 3).

Botanical family	Scientific name	Biogeographic type
Acanthaceae	*Adhatoda vasica* (L.) Pers.	Asia
	Justicia adhatoda L.	Asia
Aloeaceae	*Aloès arborescens* (C.) Presl.	Southern Africa
Amaryllidaceae	*Agapanthus africanus* L.	South Africa
	Narcissus tazetta L.	European-Mediterranean
Anacardiaceae	*schinus molle* L.	South America
Apocynaceae	*Nerium oleander* L.	Mediterranean
Araceae	*Arum maculatum* (L.) Roth.	Eurasian
Araliaceae	*Hedera canariensis* Willd	North Africa-Canary Is.
	Hedera helix L.	European-Mediterranean
	Hedera rhombea L.	Asia
Araucariaceae	*Araucaria cunninghamii* (Cav.)	Australia-Asia
Arecaceae	*Phoenix canariensis* hort. ex Chabaud	Canary Is.
	Phoenix dactylifera L.	Canary Is.-North Africa- Spain
	Syagrus romanzoffiana (Cham) Glassman	Argentine-Brazil-Paraguay
	Washingtonia filifera (Linden ex André) H. Wendl.	American-Mexican
Asparagaceae	*Yucca aloifolia* L.	American-Mexican
Asteraceae	*Bellis perennis* L.	European-Asia
	Chrysanthemum carinatum L.	North Africa
	Chrysanthemum fructescens L.	American
	Anthemis arvensis L.	Mediterranean
	Leucanthemum maximum (Ramond) DC	Mediterranean
	Tagetes patula L.	American
Bignoniaceae	*Tecoma ricasoliana* L.	South Africa
	Podranea ricasoliana L.	South Africa-Zimbabwe
Brassicaceae	*Cheiranthum cheiri* L.	European
Cannaceae	*Canna hortensis* L.	Mediterranean
Caryophyllaceae	*Dianthus caryophyllus* Poir.	European-Mediterranean
	Dianthus communis L.	Mediterranean
Casuarinaceae	*Casuarina africana* L.	Mediterranean
	Casuarina equisetifolia L.	Australia
Celastraceae	*Euonymus japonicus* L.	Asia
Cistaceae	*Helianthmum* Benth.	European-Mediterranean
Crassulaceae	*Aeonium holochrysum* L.	Canary Islands
Cupressaceae	*Thuja standishii* L.	American
Cycadaceae	*Cycas revoluta* Thunb.	Asia-Mediterranean
Fabaceae	*Acacia confuse* (L.) Roth	Asia
	Acacia dealbata Link	Australia
Geraniaceae	*Pelargonium hortorum* L.H.Bailey	South Africa
	Pelargonium peltatum L.	South Africa
	Pelargonium zonale (L.) L'Hér.	Eurasian
Hippocastanaceae	*Aesculus hippocastanum* L.	Mediterranean
Iridaceae	*Gladiolus segetum* Ker.-Gawl.	Mediterranean
	Chasmanthe aethiopica L.	South Africa
	Tritonia crocosmiiflora L.	South Africa
Lamiaceae	*Salvia officinalis* L.	European
	Salvia verbenaca L.	Mediterranean-Atlantic
	Lavendula dentata L.	Mediterranean

Lauraceae	*Laurus nobilis* L.	Mediterranean
Liliaceae	*Aspidistra eliatiae* L.	Japan
Lythraceae	*Punica granatum* L.	Mediterranean
Malvaceae	*Lavatera maritima* Gouan	Mediterranean
Meliaceae	*Melia azedarach* L.	India-China-Australia
Moraceae	*Ficus retusa* L.	Asia
Nyctaginaceae	*Bougainvillea splendens* L.	South America
Oleaceae	*Jasminum nudiflorum* Lindl.	Asia
	Ligustrum japonicum Thunb.	Eurasian
	Ligustrum vulgare L.	European-Asia-North Africa
	Syringa vulgaris L.	Asia
Onagraceae	*Fushia fulgens* L.	American-Mexican
Oxalidaceae	*Oxalis articulate* L.	American
Papaveraceae	*Fumaria capreolata* L.	Mediterranean
Pittosporaceae	*Pittosporum tobira* Banksex Gaertn.	Eurasian
Plambaginaceae	*Plumbago auriculata* Thunb.	South Africa
Poaceae	*Gynerium argentum* L.	South America
	Bambusa arundinacea L.	Asia
	Stenotaphrum americanum L.	American
Renonculaceae	*Delphinium hybride* L.	Asia
Rosaceae	*Rosa chinensis* L.	European-Asia
	Rosa hybrides L.	Mediterranean
	Prunus armeniaca L.	Armenia
	Prunus lusitanica L.	European
	Prunus x cisterna Ehrh.	Eurasian
	Eriobotyra japonica (Thunb) Lindl.	Asia
Ruscaceae	*Ruscus aculeatus* L.	Mediterranean-Atlantic
	Ruscus hypoglossum L.	European
	Ruscus hypophyllum L.	Mediterranean
Salicaceae	*Populus nigra* L.	Paleo-Temperate
Solanaceae	*Cestrum fasciculatum* L.	American
	Cestrum x cultum Pierre Francey	South America
	Datura suaveolens L.	Brazil
	Solanum pseudo-capsicum L.	American
Ulmaceae	*Celtis australis* L.	European-Mediterranean
Valerianaceae	*Centranthus ruber* Lam.	European-Mediterranean
Verbenaceae	*Lantana camara* L.	Mediterranean
	Verbena officinalis L.	Paleo-Temperate

Table 1. Floristic inventory of the 1er Juin garden station (Grand Bassin).

It should be noted that the taxonomic families which had very low attendance rates (1.22%) and represented only by one species, each were gathered and accumulated in a single portion called other families. Phytogeographically, the flora inventoried in this station is made up of a heterogeneous set of elements from various origins, of which there are 27 provenances (Table 2, Fig. 4).

Nevertheless, for a better interpretation of this criterion, it was deemed useful to categorize the approach by considering only four significant origins highlighting the role that must play this public green space supposed to shelter a mainly ornamental flora (Table 3, Fig. 4).

The advanced percentage of 72.09% has demonstrated the importance of the non-Mediterranean

Biogeographic type	Percentage (%)
Med.	18.6
Med., Atl.	2.33
Eur., Med.	6.98
Non-Med. (Asia, Southern Africa, South Africa, North Africa, Amer., South Amer., Euras., Eur., Amer.- Mex., Aust., Eur.-Asia, Eur.- Asia- North Africa, Canary Islands, Paleo-Temp, N-Africa- Canary Islands, South Africa- Zimbabwe, Argentina- Brazil- Paraguay, Armenia, Asia- Med., Aust.- Asia, Brazil, Canary Islands- North Africa- Spain, India- China- Aust., Japan)	72.09

Table 2. Biogeographical types of species inventoried in the 1er Juin station (Grand Bassin). Med.: Mediterranean, Med., Atl.: Mediterranean, Atlantic, Med., Atl.: European, Mediterranean.

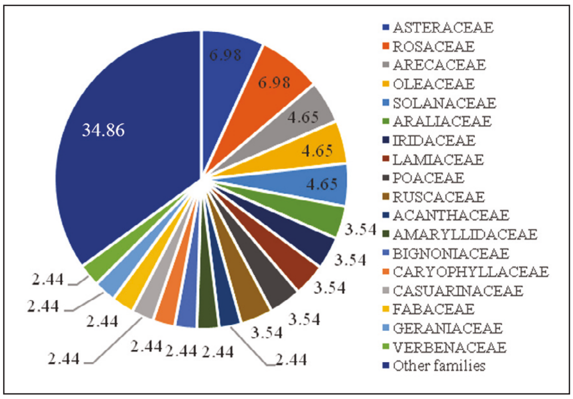

Figure 3. Distribution of botanical families in the 1er Juin station (Grand Bassin).

Biogeographic type	Percentage (%)
Non-Med.	72.09
Med., Atl.	2.33
Eur., Med.	6.98
Med.	18.6

Table 3. Recapitulative table of the biogeographic types of the species inventoried on the 1er Juin station (Grand Bassin).

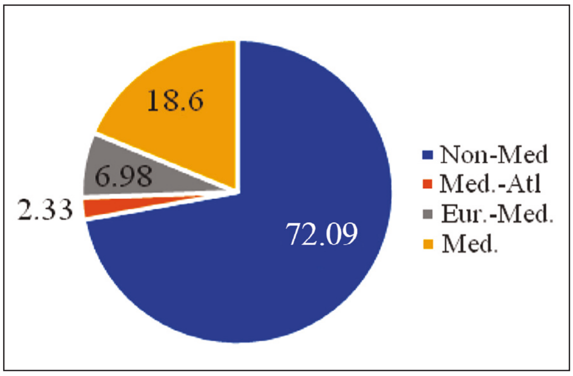

Figure 4. Distribution of biogeographic types in the 1er Juin station (Grand Bassin).

origin represented by several species including *Phoenix dactylifera* L., *Washingtonia filifera* (Linden ex André) H. Wendl., *Yucca aloifolia* L. and *Euonymus japonicas* L. compared to the Mediterranean origin (18.6%) and especially compared to the biogeographic intermediate types defined by the combined Euro-Mediterranean and Atlantic Mediterranean types (9.31%) (Table 3).

The values obtained largely confirmed the age of this space, its altitude, and particularly its permanent maintenance. This reality defines what a green space should be and its main vocation to accommodate floristically ornamental taxa. The dominance of exotic species must be carefully monitored given the potentially harmful effects it could have on the ecosystem if it becomes invasive (Sakhraoui et al., 2019).

Boujlida garden station

The floristic inventory carried out within the green space of the Boujlida station counted 24 species belonging to 12 botanical families, including that of Rosaceae which was relatively well represented with

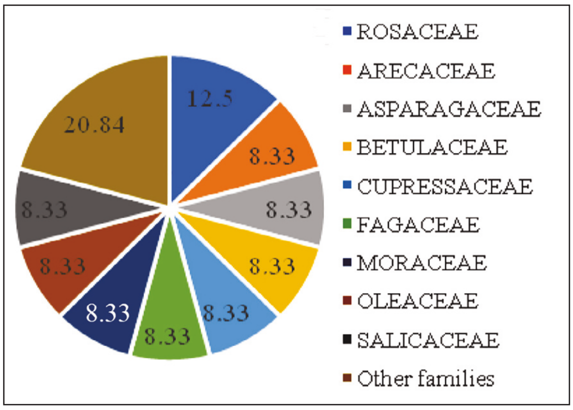

Figure 5. Distribution of botanical families in the Boujlida station.

12.5% citing the two species *Prunus domestica* L. and *Prunus pissardii* Carrière. For example, Arecaceae, Asparagaceae, Betulaceae, Cupressaceae, Fagaceae, Moraceae, Oleaceae and Salicaceae were represented with 8.33% each (Table 4, Fig. 5).

Botanical family	Scientific name	Biogeographic types
Anacardiaceae	*Schinus molle* L.	South American
Arecaceae	*Phoenix canariensis* Hort. ex Chabaud	Canary Islands
	Washingtonia filifera (Linden ex André) H. Wendl.	American-Mexican
Asparagaceae	*Dracaena draco* L.	Canary Islands
	Cordyline indivisa Steud = *Dracaena indivisa* G. Forst.	Eurasian
Asteraceae	*Gazania rigens* L. Gaertn	South Africa
Betulaceae	*Alnus glutinosa* L. Gaertin	European-Asia
	Betula alba L.	North America
Cupressaceae	*Cupressus sempervirens* L.	Eurasian
	Tetraclinis articulata (Vahl) Masters	Ibero-Mauritanian.
Fabaceae	*Erythrina crista-galli* Link.	American
Fagaceae	*Castanea sativa* Mill.	Cosmopolitan
	Quercus coccifera L.	Mediterranean-Atlantic
Moraceae	*Ficus elastica* Roxb.	Asia
	Ficus carica L.	Mediterranean
Oleaceae	*Fraxinus excelsior* L.	European
	Ligustrum japonicum Thunb.	Eurasian
Poaceae	*Festuca elatior* L.	Circumboreal
Rosaceae	*Prunus domestica* L.	Eurasian
	Prunus pissardii Carrière	European-Asia
	Rosa sp.	Cosmopolitan
Salicaceae	*Populus nigra* L.	Paleo-Temperate
	Salix alba L.	Paleo-Temperate
Sterculiaceae	*Sterculia foetida* L.	Asia

Table 4. Floristic inventory of the Boujlida garden station.

In addition, it should be noted that the other remaining families with a reduced proportion of existence, with the rate of 4.16%, and containing a single species each were amassed and accumulated into a single fragment called other families. The characterization by the biogeographic criterion of the different species inventoried in this station was heterogeneous, consisting of elements of various origins (16 biogeographic types) (Table 5, Fig. 6).

However, in the interest of a judicious interpretation and especially consistent with those used previously, we opted to consider only three geographical origins to highlight the main priority of this public green space to host flora known as ornamental (Table 6, Fig. 6). The values obtained revealed the predominance of non-Mediterranean origin (91.65%) compared to the remains and particularly towards those said to be of Mediterranean origin (4.16%) (Table 6).

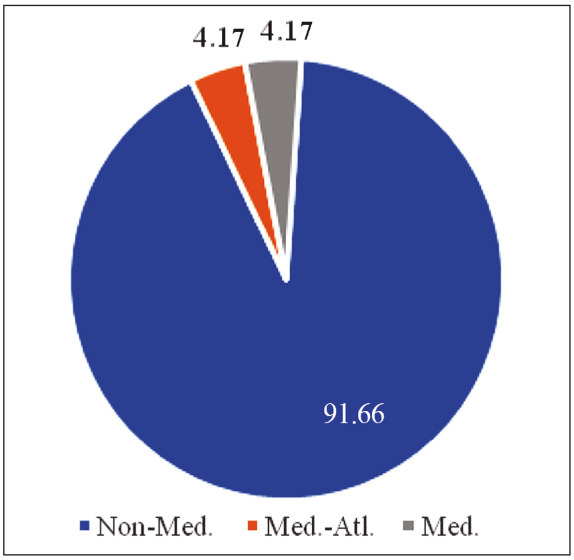

Figure 6. Distribution of biogeographic types in the Boujlida station.

It is through this approach that we note from the floristic inventory carried out that the green space studied hosts to so-called non-Mediterranean taxa with proportions markedly greater than those said to be the Mediterranean. The consideration of the so-called Atlantic Mediterranean biogeographic type in this interpretation is mainly due to its intermediate geographical position between the other two types, this situation has a definite impact on the ecological analysis of the plant components determining this space.

The figures obtained are largely due to the recent creation of this unprotected area which remains in the process of development to accommodate more ornamental species and above all to play the role of a relaxing environment for the population of the new pole urban area of Boujlida. From an ecological point of view, the maritime influence due to the medium altitude and the northern exposure of this area can only favor the introduction of new allochthonous taxa, a beneficial fact from an ornamental point of view but which also has a certain threat on the native flora heritage, hence the risk of propagation and invasion.

Biogeographic type	Percentage (%)
Med.	4.16
Med., Atl.	4.16
Non-Med. (Asia, Cosm., Euras., Eur., Ibero-Maur. Canary Islands, Paleo-temp., South Africa, Amer., North Amer., South Amer., Amer.- Mex., Circum.)	91.65

Table 5. Biogeographical types of species inventoried in the Boujlida station. Med.: Mediterranean, Med., Atl.: Mediterranean, Atlantic.

Biogeographic type	Percentage (%)
Non-Med.	91.65
Med., Atl.	4.16
Med.	4.16

Table 6. Summary table of the biogeographical types of the species inventoried in the Boujlida station.

Comparative analysis of the diversity indices of the study stations

On the Shannon's index (H), we noticed that for both stations, H is greater than zero (0) and that all the species inventoried respectively had the same abundance in their families and that they define representativeness in the sample studied. This analysis approach is more consolidated in the station of the 1er Juin garden (Grand Bassin) compared to that of the Boujlida garden. In other words, the taxa of the first station were clearly more abundant and highly representative in their sample compared to those from the second station.

On the other hand, on Piélou's equitability (E_H), the value of E_H was close to 1. This confirmed the equilibrium of the species found within their respective families regardless of the investigation station concerned in this study.

Regarding the Simpson's equitability (I_S), it was admittedly greater than 1 but significantly lower than its maximum value (that of the total number of species inventoried) at each of the two stations. But this does not prevent that at the Boujlida station, the value found of this index (I_S = 12.52) represented the equivalent of 50% in all the species, numbering 24, on the other hand in the garden station of the 1er Juin, this index only determined 30% of all species counted (I_S = 30.82 for 86 taxa).

To the latter is attached the equitability index (E_S) with a calculated average of around 0.64 and

Study zone	Shannon's index (H)	Piélou's equitability (E_H)	Simpson's index (I_S)	Simpson's equitability (E_S)	Margalef's index (D_{mg})
Grand Bassin garden, 1er Juin	5.24	0.94	30.82	0.64	10.32
Boudjlida garden	3.72	0.97	12.52	0.88	4.09

Table 7. The diversity indices calculated for the two stations.

0.88 respectively for the stations of the 1er Juin garden and Boujlida garden. The value obtained in the Boujlida station is almost close to 1, thus determining the differences in the abundance of individuals between each species, on the other hand in the station of the 1er Juin garden, the value was less, close to 1 indicating differences in the abundance of individuals between each species moderately equal.

Finally, the result obtained on the Margalef's index (D_{mg}) relating to the two studied stations confirms the fact that the latter has the (D_{mg}) greater than zero (0) but far from being equal to its maximum value confirming the membership of at least two species per family in each of the two studied stations.

CONCLUSIONS

The study approach taken on the two public green spaces belonging to the urban perimeter of the city of Tlemcen (Northwest of Algeria) revealed an interesting floristic composition both for the number of families listed which was around 60, for the number of species belonging to the latter which is equal to 110 as well as the biogeographical origin of these taxa which was from different provenances.

All these elements have prompted us to develop the analysis of floristic diversity based on diversity indices recognized as being topical, especially since the two stations are home to a significant specific richness composed mainly of typically ornamental flora highly adapted ecologically under the conditions of the Mediterranean region.

The results obtained on the diversity indices calculated by Shannon show that the garden of 1er Juin (Grand Bassin) has significant representativeness on the species enumerated about their taxonomic families compared to those of the garden of Boujlida.

For the Simpson's index, the Boujlida garden determined a high degree of representativeness between the number of families and the number of species belonging to these families (50%); on the other hand, this weighting was not confirmed in the 1er Juin garden (Grand Bassin) which in fact was only of the order of 30%.

Regarding the future development plan to be recommended for the two gardens, we want the introduction of new Mediterranean taxa, in particular those recognized as ornamental, with a view to a more interesting floristic diversity encouraging and preserving at the same time the autochthonous floristic heritage and thus offering to these two sites to provide a pleasant ecological setting allowing it to exercise its main function of green space and even an eco-tourist places of visits.

REFERENCES

Aboura R. & Siba A., 2018. Variabilité climatique et aridité dans la région de Tlemcen (Algerie). Journal international Sciences et Techniques de l'eau et de l'environnement, 3: 45–48. http://jistee.org/journal-istee-2018/

Ainad Tabet M., 1996. Contribution à l'étude des groupements à Thuya (*Tetraclinis articulata* Vahl.) dans la partie Nord occidentale de l'Algérie: aspects écologiques et cartographie. Thèse de Magister Université Tlemcen, 111 pp.

Alcaraz C., 1982. La végétation de l'Ouest algérien. Thèse Doctorat es-sciences Université Perpignan, 415 pp. + annexes.

Alcaraz C., 1969. Etude géobotanique du Pin d'Alep dans le Tell oranais, Montpellier, Thèse Doctorat Université Montpellier, 183 pp. + annexes.

Angiosperm Phylogeny Group, 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III, Botanical Journal of the Linnean Society, 161: 105–121, https://doi.org/10.1111/j.1095-8339.2009.00996.x

Bagnouls F. & Gaussen H., 1953. Saison et indice xérothermique. Document cartographique production végétale. Général II, 1, article VIII, Toulouse, 47 pp.

Benabadji N. & Bouazza N., 2000. Quelques modifications climatiques intervenues dans le Sud-Ouest de l'Oranie (Algérie occidentale). Revue des Energies Renouvelables, 3: 117–125.

Bolund P. & Hunhammar S., 1999. Ecosystem services in urban areas. Ecological Economies, 29: 293–301.

Calenge C., 1997. De la nature de la ville. Les annales de la recherche urbaine, 74.

Chaumont M. & Paquin C., 1971. Notice explicative de la carte pluviométrique de l'Algérie 1/500.000. Publications de la Société d'Histoire Naturelle de l'Afrique du Nord, 24 pp.

Clergeau PH., 1996. Une biodiversité urbaine, Le Courrier du CNRS, 82: 1–102.

Dahmani M., 1997. Le chêne vert en Algérie. Syntaxonomie, phytosociologie et dynamique des peuplements. Thèse Doctorat es-sciences Université U.S.T.H.B. Alger, 383 pp.

Dajoz R., 1982. Precis d'écologie. Ecologie fondamentale et appliquée. Quatrieme Ed. Gauthiers villars. Bordas, Paris, 493 pp.

Daures J.F., 2011. Architecture végétale. Eyrolles editeur, 250 pp.

Debrach J., 1953. Notes sur les climats du Maroc occidental. Maroc Médical, 32: 1122–1134.

Emberger L., 1930. La végétation de la région méditerranéenne. Essai de classification des groupements végétaux. Revue générale de botanique, 641: 705–721.

Emberger L., 1952. Sur le quotient pluviothermique. Comptes rendus de l'Académie des Sciences, 234: 2508–2511.

Emberger L., 1955. Une classification biogéographique des climats. Travaux des Laboratoires de botanique, géologie et zoologie de la Faculté des sciences de l'Université de Montpellier. Série zoologique, 7: 3–43.

Frontier S. & Pichod-Viale D., 1993. Ecosystèmes, structure-fonctionnement, évolution. Collection d'Écologie, 21. Ed. Masson, 447 pp.

Hadjadj Aouel S., 1995. Les peuplements du thuya de Berberie (*Tetraclinis articulata* Vahl.) en Algérie, phytoécologie, syntaxonomie, potentialités sylvicoles. Thèse Doctorat en Sciences, Université Marseille III. 159 pp + annexes.

Magurran A.E., 2004. Measuring Biological diversity. Oxford and Victoria: Blackwell Publishing, Malden, 256 pp.

Mathieu N., 2000. Repenser la nature dans la ville: un enjeu pour la géographie, Natures sciences et societies, 8: 74–82. https://doi.org/10.1016/S1240-1307(00)80070-9.

Puiboub D., 1996. Jardins régionaux, Paris (France). Edition Nathan, 191 pp.

Quézel P. & Santa S., 1962–1963. Nouvelle flore de l'Algérie et des régions méridionales. CNRS, Tomes I et II, 1190 pp.

Quézel P., 1991. Structure de végétation et flore en Afrique du Nord. Leurs incidences sur les problèmes de conservation. Ed. Acte, pp. 19–32.

Sakhraoui N., Metallaoui S., Chefrour A. & Hadef A., 2019. La flore exotique potentiellement envahissante d'Algérie: première description des espèces cultivées en pépinières et dans les jardins. Biotechnologie, Agronomie, Société et Environnement, 23: 63–73.

Smith R.M., Thompson K., Hodgson J.G., Warren P.H. & Gaston K.J., 2006. Urban domestic gardens (IX): composition and richness of the vascular plantflora, and implications for native biodiversity. Biological Conservation, 129: 312–322.

Tabti N., 2017. Etude comparée de l'effet de Bacillus thuringiensis sur les populations purifiées et des populations des gîtes artificiels de *Culex pipiens* (Diptera Culicidae) dans la ville de Tlemcen. Thèse Doctorat Université Tlemcen, 163 pp.

Turner K., Lefler L. & Freedman B., 2005. Plant communities of selected urbanized areas of Halifax, Nova. Scotia, Canada. Landscape and Urban Planning, 71: 191–206.

Walter J-M.N., 1994-2006. Méthodes d'étude de la végétation. Méthodes du relevé floristique. 1ere partie: Introduction; 2eme partie: Exercice. Institut de Botanique-Faculté des sciences de la Vie- Université Louis Pasteur. Strasbourg.