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DIVERSITY OF SPONTANEOUS PLANTS IN PUBLIC GARDENS AT ARID ENVIRONMENTS

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Abstract
Public gardens are necessary to improve the quality of life, and wellbeing of urban residents. The objective of this study was to inventory the floristic diversity of spontaneous species in three sites representing different public gardens in southwestern Algeria. To document all spontaneous species present, a total of 64 quadrats were established in August 2021. To express differences in diversity between sites, the species richness and biological diversity index were used. A total of 375 individuals, representing 15 families, 29 genera, and 31 species were recorded. The family Asteraceae is represented by the highest number of species (7 species) followed by Amaranthaceae and Poaceae (5 species), whereas, 10 families are represented by one species each. Therophytes (58.06%) and Chamephytes (16.13%) are relatively high life forms of the vegetation spectra. Phytogeographical analysis of the vegetation in the area revealed the forte representation of cosmopolitan elements. The ranges of diversity indices observed in the three sites were: Shannon-Weaver index (2.99-3.86), Evenness index (0.76-0.88) and Sørensen coefficient (53%-61%). The application of principal component analysis to the data characterized the ecological gradients responsible for the distribution of these taxa at the level of the three sites. This study contains important information on spontaneous plants in arid environments, which should be integrated into the priority of plant genetic resources valorization programs.

Keywords: arid environment, plant diversity, public gardens, spontaneous plants.

1. INTRODUCTION

Due to the presence of edible plants, medicinal plants, and economic species, drylands are one of the most economically important ecosystems (Ghahremaninejad et al., 2021). Biodiversity is important in drylands because it is the nature with which more than half of the world's population interacts daily (Kuras et al., 2020). The green spaces in cities are an essential component in the production of ecosystem services that benefit human health and well-being (Lundholm and Richardson, 2010; FAO, 2011; Tam and Bonebrake, 2016; Flores et al., 2020; Souddi and Bouallala, 2021). The gardens and parks have special microclimates for the development of new plant communities (Caixinhas and Liberato, 1995; Marco et al., 2008; Marco et al., 2010). These spaces are the main source of the introduction of exotic species and they are the main place of development of spontaneous species (Bossu et al., 2011). These species have certain uses pastoral, fodder, food, aromatic and medicinal (Abdelguerfi and Laouar, 1999; Al-Yemeny, 1999; Ohba and Amirouche, 2003). Evaluating and determining the plants propagated in the public gardens are

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required for the development of effective management strategies of urban green spaces. It is a good criterion for estimating the biodiversity of spontaneous species in gardens, parks, and landscaping (Chindyaeva et al., 2018).

In this study, we aimed to determine the composition and diversity of spontaneous plants in three public gardens. Specifically, we analyzed (a) species richness and biological diversity index (Shannon index, evenness and Sørensen coefficient (b) ecological spectra (life forms, Phytogeographical types and dissemination types).

2. MATERIALS AND METHODS

2.1. Study Area

Three sites in the region of Adrar represent different public gardens. These sites are located in the town of Tamentit (Fig. 1), a town located 10 km south of the chief town of Adrar. These sites were selected based on their diversity of spontaneous plants present.

According to the records of Infoclimat website (www.infoclimat.fr) for the period 2000-2020, the average minimum temperature for the study area was 17.8 °C in January and a mean maximum temperature was 34 °C in July with an annual mean temperature of 25.9 °C. Rainfall in the region is irregular; the average annual precipitation is 4.4 mm.

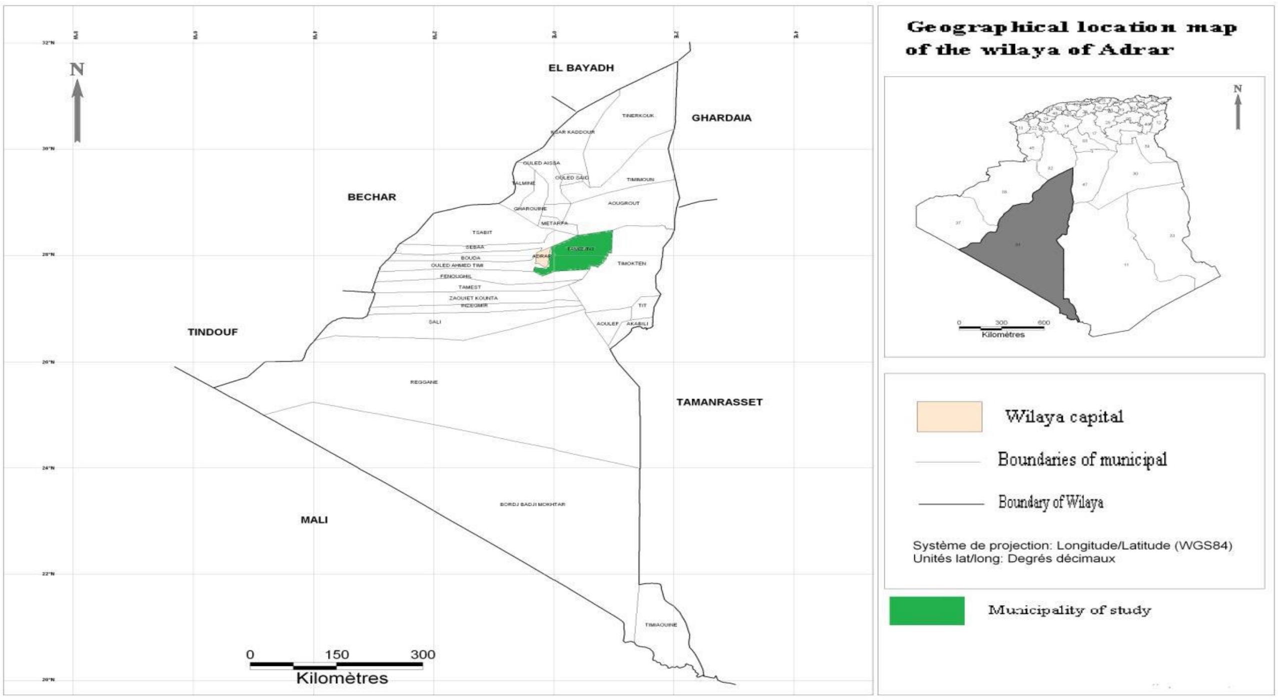

Figure 1. Geographical location of the study station (Tamentit, SW Algeria) (Souddi and Bouallala, 2021)

2.2. Data collection methods and selection of study sites

The inventory was carried out during the month of August 2021 on a plot of 1 m x 1 m or 1 m^2. The month of August was chosen for sampling because it coincided with an increase in temperature and a decrease in the amount of available water to stimulate germination and growth for most plants. In total, 64 phytoecological surveys were performed (Site 1: 20 surveys; Site 2: 25 surveys; Site 3: 19

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surveys). In each quadrat, we recorded the abundance of each plant species present by calculating the number of individuals (Gounot, 1969).
Site 1 (27°46'08'' N, 0°16'12'' W, elevation: 236 m) is located between the houses. This garden is dominated by: *Tamarix aphylla* (L.) H. Karst, *Dodonea viscosa* (L.) Jacq.
Site 2 (27°44'42''N, 0°16'09'' W, elevation: 243 m) is located on the road between Adrar and Reggan. The dominant species are: *Tamarix aphylla* (L.) H. Karst, *Phoenix dactylifera* L. and *Casuarina equisetifolia* L.
Site 3 (27°42'37''N, 0°16'29'' W, elevation: 245 m) is located at 4 km south of Tamentit. This garden is dominated by: *Leucaena leucocephala* (Lam.) de Wit, and *Casuarina equisetifolia* L. Plants species were identified using the flora of Quézel and Santa (1962-1963) and Ozenda (2004).

2.3. Data analyses

The ecological parameters and indices used:
Spatial occurrence (frequency of occurrence (Occ): Occ (%) = k/K × 100
Where k: the number of records species, K: the sum of species present (Faurie et al., 2003).
Plant species are classified into five occurrence classes: Class I (very rare species): Occ < 20%, Class II (rare species): 21 < Occ < 40%, Class III (frequent species): 41 < Occ < 60%, Class IV (abundant species): 61 < Occ < 80%, Class V (species abundant and constant): Occ > 80 % (Bensizerara et al., 2013).
Species diversity: For each garden, biological indices (species richness, evenness, and Sørensen coefficient) of spontaneous plants were calculated.
The number of species present in each quadrat is considered to be species richness (Flores et al., 2020).
Shannon's index (H'): calculated as follows: $H' = - \Sigma (pi) * \log_2 (pi)$
Where H' = Shannon index of species diversity, Pi = Proportion of the total number of individual species i (Shannon and Weaver, 1948).
Evenness (E): It was calculated as: $E = H'/H_{max}$
where $H_{max} = \log_2 S$. The value of evenness varies from 0 to 1, with 0 indicating the dominance of a single species, and 1 indicates that all population densities are evenly distributed (Piélou, 1966).
Coefficient of similarity (Cs): The similarity coefficient can be used to determine the similarity of floras from different sites in the study area (Sørensen, 1948). It was calculated as:

$$Cs = \frac{2c}{a + b} X\ 100$$

a and b represent the lists of the species recorded respectively in the two sampling units that we want to compare, and **c** the number of species common to both lists a and b (Souleymane et al., 2018).
Plant characteristics
Life forms: The Raunkiaer scheme was used to identify the life forms of the recorded species (Raunkiaer, 1934).
Morphological types: Depending on the persistence of the aerial part during the unfavorable season, plants can be classified as perennial or annual (Bouallala et al., 2020).
Phytogeographical types: phytogeographical properties of the recorded species were determined using the flora of Algeria and desert regions (Quézel and Santa, 1962-1963).

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Dispersal types: Based on Van der Pijl (1982), the dispersal types of the recorded species were determined.

2.4. Statistical analyses

Principal component analysis (PCA) is the most used method for data exploration and data analysis across all fields of science (Jolliffe, 1986). The goal is to identify a reduced set of features that represent the original data in a lower-dimensional subspace with a minimal loss of information (Abdi and Williams, 2010). Principal component analysis was used to analyze the vegetation using the software "Minitab 16". The abundance total of each plant species in each site was used in the correspondence analysis.

3. RESULTS AND DISCUSSIONS

3.1. Floristic composition and structure

Thirty-one species belonging to 29 genera and 15 families were recorded (Table 1). The number of species recorded in this study was found to be lower than that reported by Souleymane et al. (2018) in the vegetable gardens of the Ivory Coast. This low plant diversity is a common characteristic of hot drylands, where the vastness of arid lands, low primary productivity, and low plant population densities all contribute to the low biodiversity (Bradai et al., 2015; Bouallala et al., 2020).

The Asteraceae family is represented in public gardens with (22.6%). This family is the largest angiosperm family, with the largest number of species (El-Ghanim et al., 2010). These species hug capabilities in seeds production and dispersal methods under arid climatic conditions (Balah, 2019). The Amaranthaceae and Poaceae family represent (16.14%), Apocynaceae and Solanaceae (6.46%), which indicates that these families better adapted to arid environments (Le Houérou, 1992; Traoré et al., 2010; Bradai et al., 2015). Furthermore, 10 families were represented by one species (Cucurbitaceae, Cyperaceae, Euphorbiaceae, Fabaceae, Juncaceae, Malvaceae, Portulacaceae, Primulaceae, Resedaceae and Zygophyllaceae). The presence of monospecific families was the main characteristic of the plant assemblage in arid regions.

On the 375 individuals (Table 2), the species *Erigeron bonariensis* L. is the most abundant with a total of 59 individuals (15.73 %), its density was highest at Site 2 where it registered 22.09 individuals per plot (1 m^2). The abundance of *E. bonariensis* due to its capability of producing 200,000 viable seeds per plant and establishing under different environmental conditions (Verdeguer et al., 2020). They occupy anthropogenic habitats, such as abandoned fields, crops and waste ground, as well as natural and semi-natural communities (Liendo et al., 2021).

The species *Calotropis procera* Act. is the most frequent with (Occ =26.56 %). *C. procera* is widespread in open habitats; it can become particularly abundant in abandoned cultivation, sandy soils in areas with low rainfall and disturbed and overgrazed areas (Dhileepan, 2014). Each plant of *C. procera* produces hundreds to thousands of seeds, which are dispersed by the wind and animals (Elimam et al., 2009).

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Table 1. List of plants recorded in the study area with their traits and ecological characteristics

Family	Species	Plant's code	Life forms	Dispersal types	Morphological types	Chorological types
Amaranthaceae (16.14%)	*Amaranthus albus* L.	Am al	TH	Zoo	Annual	N. Amer
	Amaranthus retroflexus L.	Am re	TH	Zoo	Annual	N. Amer
	Bassia muricata (L.) Asch.	Ba mu	TH	Zoo	Annual	Sah.
	Chenopodium murale L.	Ch mu	TH	Baro	Annual	Cosm.
	Salsola foetida Del.	Sa fo	CH	Anemo	Perennial	Sah. Arab.
Apocynaceae (6.46%)	*Calotropis procera* Act.	Ca pr	PH	Anemo	Perennial	Sahelo-Sah.
	Cynanchum acutum L.	Cy ac	GE	Baro	Perennial	Med. As.
Asteraceae (22.6%)	*Erigeron bonariensis* L.	Er bo	TH	Anemo	Annual	Amer.
	Lactuca serriola L.	La se	TH	Anemo	Annual	Paleotemp.
	Launaea nudicaulis (L.) Hook. f.	La nu	TH	Anemo	Annual	Med. Sah. Arab.
	Launaea resedifolia O.K.	La re	TH	Anemo	Annual	Med. Sah. Arab.
	Pulicaria arabica (L.) Cass.	Pu ar	HE	Anemo	Perennial	N. Afr.
	Sonchus oleraceus L.	So ol	TH	Anemo	Annual	Cosm.
	Leontodon hispidulus (Del.) Boiss.	Le hi	TH	Anemo	Annual	Med.
Cucurbitaceae (3.22%)	*Colocynthis vulgaris* (L.) Schrad	Co vu	TH	Zoo	Annual	Trop. Med
Cyperaceae (3.22%)	*Cyperus rotundus* L.	Cy ro	GE	Baro	Perennial	Sub trop.
Euphorbiaceae (3.22%)	*Euphorbia granulata* Forsk.	Eu gr	TH	Baro	Annual	Sah. Arab.
Fabaceae (3.22%)	*Cassia aschrek* Forsk.	Ca as	CH	Baro	Perennial	Sud-Dec. Sah.
Juncaceae (3.22%)	*Juncus maritimus* Lamk	Ju ma	GE	Zoo	Perennial	Cosmop.
Malvaceae (3.22%)	*Malva parviflora* L.	Ma pa	TH	Baro	Annual	Med.
Portulacaceae (3.22%)	*Portulaca oleracea* L.	Po ol	TH	Baro	Annual	Cosmop.
Primulaceae (3.22%)	*Anagallis arvensis* L.	An ar	TH	Baro	Annual	Sub. cosmop.
Poaceae (16.14%)	*Cynodon dactylon* (L.) Pers.	Cy da	HE	Baro	Perennial	cosm.
	Dactyloctenium aegyptium (L.) Willd.	Da ae	TH	Baro	Annual	Pantrop.
	Imperata cylindrica (L.) Räusch.	Im cy	HE	Anemo	Perennial	Cosm.
	Phragmites communis Trin.	Ph co	HE	Anemo	Perennial	Cosm.
	Setaria viridis (L.) P. Beauv	Se vi	TH	Zoo	Annual	Temp.-Subtrop.
Resedaceae (3.22%)	*Randonia africana* Coss.	Ra af	CH	Baro	Perennial	Sah.
Solanaceae (6.46%)	*Hyoscyamus muticus* L.	Hy mu	TH	Zoo	Annual	Sah. Arab.
	Solanum nigrum L.	So ni	CH	Zoo	Perennial	Cosmop.
Zygophyllaceae (3.22%)	*Zygophyllum album* L. f.	Zy al	CH	Baro	Perennial	Sah. Arab.

Life forms :(CH: Chamaephyte, HE: Hémicryptophyte, PH: Phanérophyte, TH: Thérophyte, GE: Géophyte).
Dispersal types : (**Anemo** : Anemochorus**, Baro** : Barochorus, **Zoo** : Zoochorus),
Chorological types: N. Amer: North. American, Sah: Saharan, cosm: cosmopolitan, Sah.Med: Saharo-Mediterranean, Sahelo-Sah: Sahelo-Saharan, Med. As: Mediterranean-Asian, Amer: American, Paleo-temp: Paleo-temperate, Med Sah-Arab: Mediterranean Saharo-Arabian, N.Afr: North African, Med: Mediterranean, Trop Med: Tropical Mediterranean, Sub-trop: Sub-tropical, Sah-Arab: Saharo- Arabian, Sud-Dec. Sah: Sudan -Dec. Saharan, Sub Cosmop: Sub Cosmopolitan, Pantrop: Pantropical, Temp-Subtrop: Temperate-Subtropical.

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Table 2. List of spontaneous plants, the mean density of individual numbers of taxa per site and the study area with values and scale of occurrence (Occ)

Species	Site 1	Site 2	Site 3	All sites	Total	Occ(%)	Scale Occ
Amaranthus albus L	2.86	-	-	0.95	2	3.12	Class I
Amaranthus retroflexus L.	2.86	-	-	0.95	2	3.12	Class I
Bassia muricata (L.) Asch	4.28	-	4.25	2.84	5	6.25	Class I
Chenopodium murale L.	7.14	-	-	2.38	5	6.25	Class I
Salsola foetida Del.	2.86	1.94	-	1.6	7	7.81	Class I
Calotropis procera Act.	5.71	-	2.13	2.61	22	26.56	Class II
Cynanchum acutum L.	-	0.77	2.13	0.97	3	4.69	Class I
Erigeron bonariensis L.	1.43	22.09	2.13	8.55	59	15.62	Class I
Lactuca serriola L.	-	9.30	-	3.1	24	10.94	Class I
Launaea nudicaulis (L.) Hook. f.	4.28	0.77	-	1.68	5	4.69	Class I
Launaea resedifolia O.K.	1.43	0.39	2.13	1.32	3	4.69	Class I
Pulicaria arabica (L.) Cass.	-	17.83	-	5.94	46	4.69	Class I
Sonchus oleraceus L.	1.43	-	6.38	2.60	4	6.25	Class I
Leontodon hispidulus (Del.) Boiss.	-	0.39	-	0.13	1	1.56	Class I
Colocynthis vulgaris (L.) Schrad	1.43	0.39	-	0.61	2	3.12	Class I
Cyperus rotundus L.	-	-	42.5	14.17	20	1.56	Class I
Euphorbia granulata Forsk.	1.43	10.08	2.13	4.55	28	15.62	Class I
Cassia aschrek Forsk.	-	0.77	-	0.26	2	1.56	Class I
Juncus maritimus Lamk	10	-	6.38	5.46	10	7.81	Class I
Malva parviflora L.	1.43	-	-	0.48	1	1.56	Class I
Portulaca oleracea L.	2.86	-	-	0.95	2	3.12	Class I
Anagallis arvensis L.	2.86	-	-	0.95	2	1.56	Class I
Cynodon dactylon (L.)Pers.	1.43	5.81	10.64	5.96	21	10.94	Class I
Dactyloctenium aegyptium (L.) Willd.	10	0.39	2.13	4.17	9	7.81	Class I
Imperata cylindrica (L.) Räusch.	-	5.81	-	1.94	15	3.12	Class I
Phragmites communis Trin.	12.86	12.01	2.13	9.01	41	9.37	Class I
Setaria viridis (L.) P.Beauv	-	-	4.25	1.42	2	1.56	Class I
Randonia africana Coss.	-	-	2.13	0.71	1	1.56	Class I
Hyoscyamus muticus L.	2.86	2.32	-	1.73	8	4.69	Class I
Solanum nigrum L.	-	1.55	-	0.52	4	3.12	Class I
Zygophyllum album L. f.	18.57	0.77	8.51	9.28	19	23.44	Class II
Total	70	258	47		375		

3.2. Life form spectrum

The life-form spectrum of the recorded species indicated the predominance of Therophytes (18 species or 58.06% of the total species) (Fig.2). A forte representation of Therophytes at Site 1 with (15 species or 71.44 % of presence). The high proportions of Therophytes because all the study sites were open for anthropic action. This is favorable for heliophilous species; especially Therophytes (Souleymane et al., 2018). Therophytes represents the ultimate stage of the adaptation of plants to artificialized environments (Godron, 1974). The presence of chamaephytes in the study area with five species (16.13%) is due to their adaptations to aridity (Chenchouni, 2012; Bouallala, 2013; Bradai et al., 2015). Hemicryptophytes were represented by four species with 12.9%. These species adapt well to arid and semi-arid environments and maintain themselves thanks to vegetative organs (bulbs, rhizomes, stolons) (Taleb et al., 1998). Geophytes with three species (9.68%). According to Taleb et al. (1998), geophytes reproduce mainly by vegetative reproduction. For most species, sexual reproduction is rare, including *Cynodon dactylon* and *Cyperus rotundus*, for which

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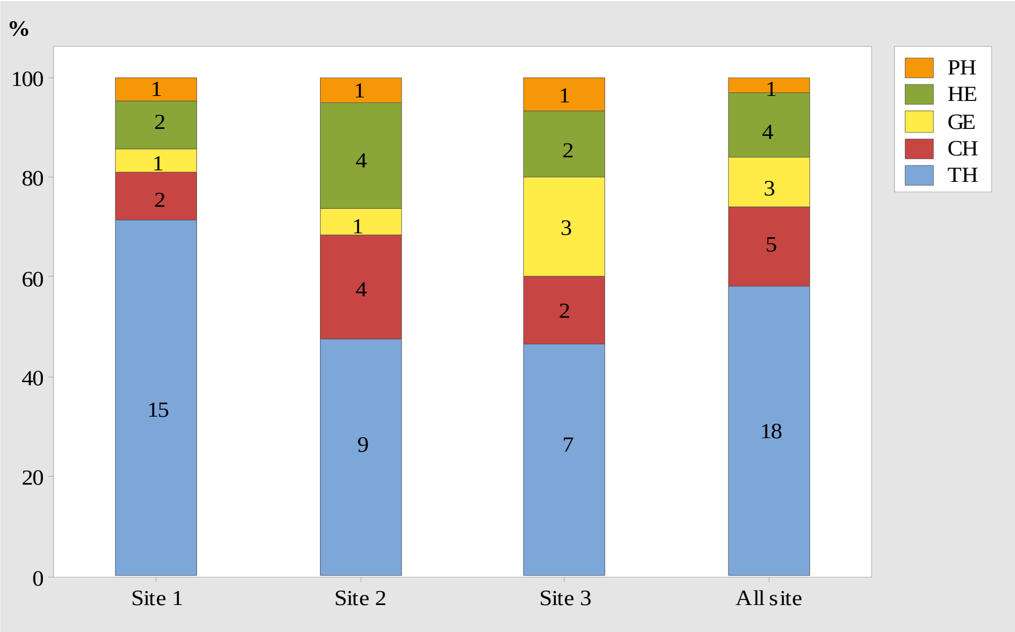
germination has never been reported. Phanerophytes were represented exclusively by one species (*Calotropis procera*) with 3.23%. Their presence confirms the study area is exposed to wind (Shmida et al., 1986; Bradai et al., 2015).



PH: Phanérophyte, HE: Hémicryptophyte, GE: Géophyte, CH: Chamaephyte, TH: Thérophyte,

Figure 2. Life forms distribution of plant species in the study area

3.3. Morphological types

The vegetation in the study area included 18 annual plants and 13 perennials. The spectrum indicated a good representation of annual species with 58.07%, while 41.93% were perennial (Fig. 3). Site 1 had the largest number of annual species with (15 species or 71.43%), the annual species is generally macro thermal or macro eurythermic (Nègre, 1961) requiring high temperatures for their germination (Taleb et al., 1998). However, the dominance of annuals reflexes the intensifications of humans (Balah, 2019).

Furthermore, Site 2 had the largest number of perennial species with (10 species or 52.63%). Hope et al. (2003) found that the species richness of perennial plants was doubled in urbanized areas. Perennial plants grow more rapidly in periods with favorable conditions and regenerate the population by asexual reproduction, thereby ensuring the survival of the species (Knevel and Lubke, 2005).

3.4. Phytogeographical types

The flora of the surveyed public gardens had a typical cosmopolitan phytogeographical affinity with eight taxa, i.e. 25.83 % of total plants (Fig. 4). Cosmopolitan species are indicators of the modifications on biodiversity by human impacts and activities (Shochat et al., 2006; El-Saied et al., 2015). Rana et al. (2001) find that contamination of grains and other economic plants, importation of seed and propagation by plant introduction agencies, and general migration of people are the primary sources for the introduction of exotic plants. The presence of the Saharo-Arabian element

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in the second position with four species (9.69 %), can explain the adaptation of species to the severe environmental conditions of hot arid lands (Quézel, 1965; Bradai et al., 2015).

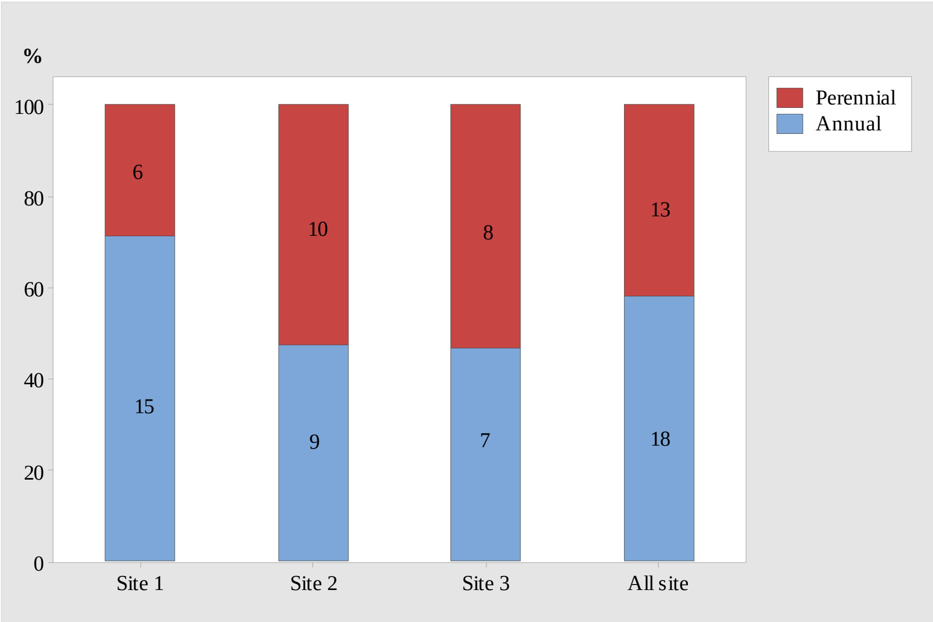
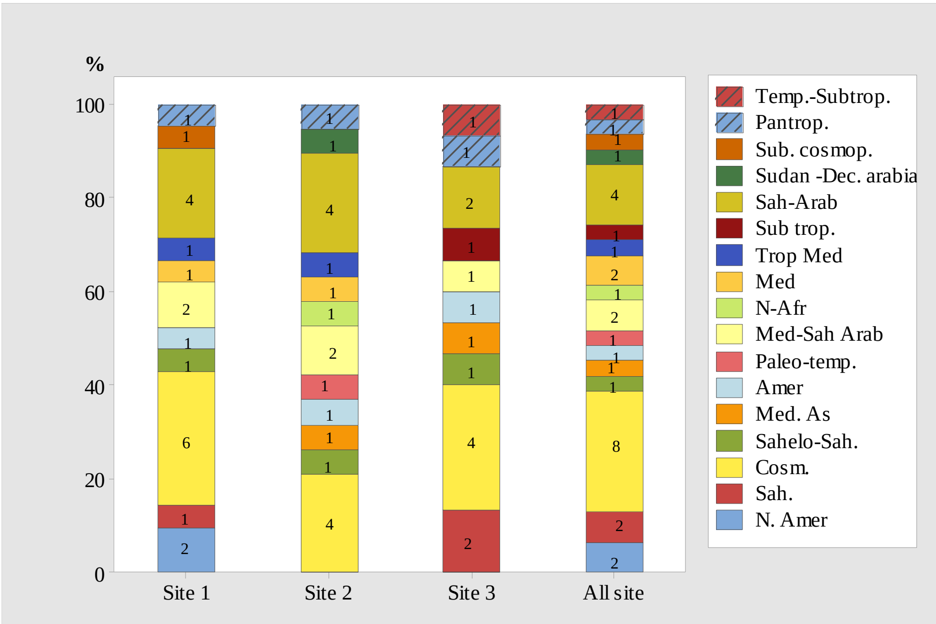


Figure 3. Morphological types distribution of plant species in the study area



N. Amer: North. American, Sah: Saharan, cosm: cosmopolitan, Sah.Med: Saharo-Mediterranean, Sahelo-Sah: Sahelo-Saharan, Med. As: Mediterranean-Asian, Amer: American, Paleo-temp: Paleo-temperate, Med Sah-Arab: Mediterranean Saharo-Arabian, N.Afr: North African, Med: Mediterranean, Trop Med: Tropical Mediterranean, Sub-trop: Sub-tropical, Sah-Arab: Saharo- Arabian, Sud-Dec. Sah: Sudan -Dec. Saharan, Sub Cosmop: Sub Cosmopolitan, Pantrop: Pantropical, Temp-Subtrop: Temperate-Subtropical.

Figure 4. Phytogeographical types distribution of plant species in the study area

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3.5. Dispersal types

For dispersal types, barochorous-type plants were abundant at all sampled sites, with (38.71%) (Fig. 5). The abundance of barochorous species is due to the permanent presence of water and the accumulation of nutrients (Kouamé et al., 2017). The high nutrient levels resulted in an increase in vegetation composition, species richness and may be created by the cultivation activities (Balah, 2019). The frequencies of anemochorous species were 35.48%. This obviously highlights the important role of wind in the dispersion of both plants and particles of soil surface (Bradai et al., 2015). The frequencies of zoochorus species were 25.81%. The dissemination of species by zoochorous-type suggests the importance of fauna in urban areas that helps maintain seed dispersal (Bossu et al., 2014).

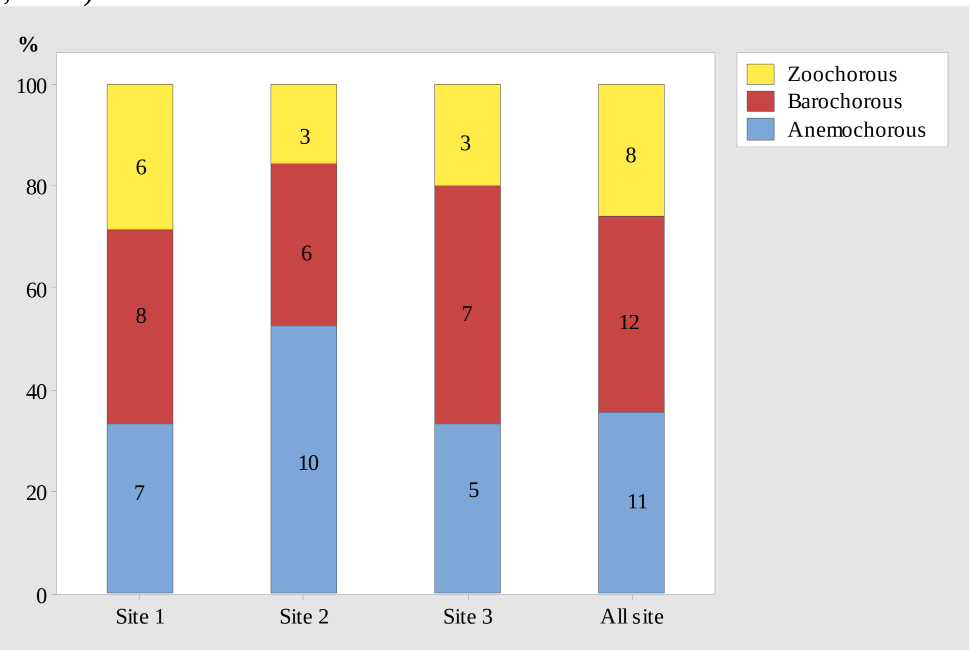

Figure 5. Dispersal types distribution of plant species in the study area

3.6. Diversity indices

The diversity of spontaneous species in public gardens differs from site to site. The diversity of spontaneous species at each site was calculated using the Shannon-Weaver index (H'). This index showed that the highest diversity was at site 1 with H'= 3.86 bits followed by Site 2 with H'= 3.22 bits. The lowest diversity was at site 3 with H'= 2.99 bits. This difference is due to the presence of water and in combination with human impacts. The Shannon diversity index (H') usually has a value of 1.5 to 3.5 and rarely reaches 4 (Picardal et al., 2011; Valenzuela et al., 2013; Flores et al., 2020). The lowest evenness index in site 2 and site 3 (0.76) and maximum in site 1 (0.88). Evenness reflects the relative abundance of species, being highest when species have similar relative abundance (Garces and Flores, 2017; Flores et al., 2020). The highest Sørensen index between site 1 and site 3 with 61%. This high similarity could be explained by the similarity of the cultivation techniques practiced in these gardens (Alfudhala, 2009).

3.4. Statistical analyses

The sum of two axes (Axis1- Axis 2) of the correspondence analysis was 70.6 % of cumulative inertia (Fig. 6). We have distinguished three groups: the first site is characterized by

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Dactyloctenium aegyptium (L.) Willd, *Juncus maritimus* Lamk. and *Zygophyllum album* L. f. *Dactyloctenium aegyptium* is characterized by its ability to eliminate the entire crop cycle provided that the soil is sufficiently humid (Le Bourgeois and Marnotte, 2002). *Juncus martimus* is localized in salty or brackish areas where the water table never drops below 80 cm (Nègre, 1962).
The second site is characterized by *Erigeron bonariensis* L. and *Pulicaria arabica* (L.) Cass. Plants of site 2 are mainly anemochorous. *Pulicaria arabica* is a hygrophilic species (Nègre, 1962). *E. bonariensis* is an annual species, that adapts to all types of soil and supports high organic matter contents (Nègre, 1962). Balah (2019) found the effect of soil organic matter, coarse sand, fine sand, silt, and soil saturation point on the spatial distribution of weed communities.
The third site is characterized by a fort presence of *Cyperus rotundus* L. It is a hygrophile and thermophilic species (Montégut, 1983). This plant researches for deep fine sands a little wet specially cultivated (Nègre, 1961). Their great adaptability to their environment gives them the potential invasion (Souleymane et al., 2018).

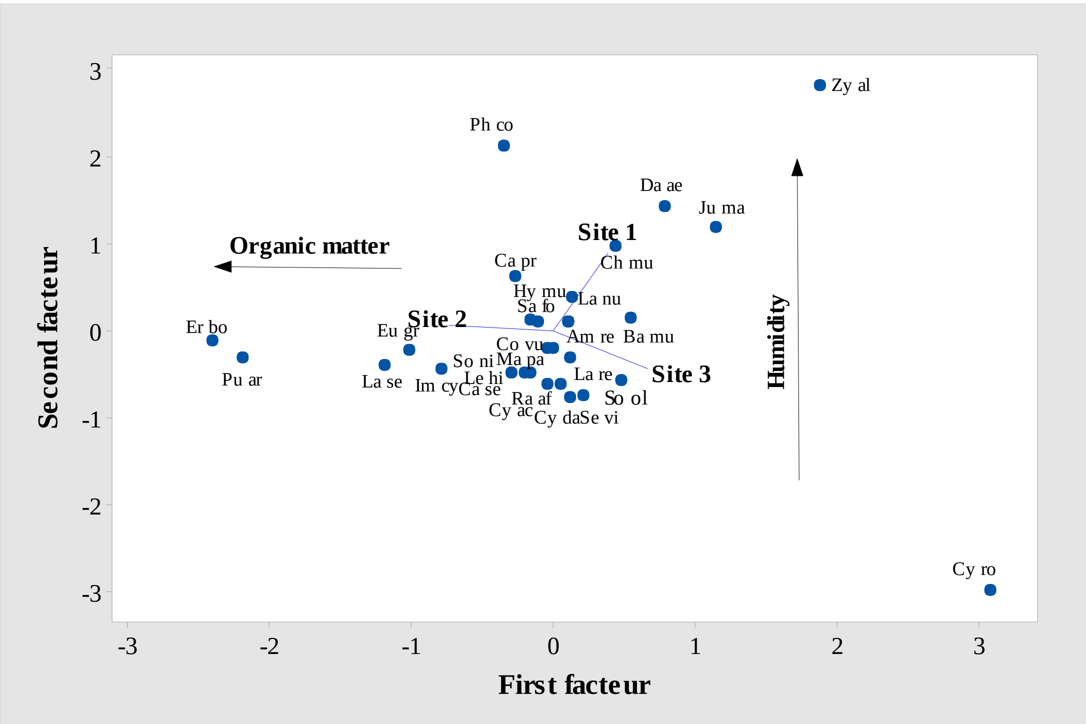

Figure 6. Principal Component Analysis of plant species in the study area.

4. CONCLUSIONS

Public gardens in southwest Algeria contained 31 species dominated by the Asteraceae followed by the Amaranthaceae and Poaceae. The current climatic conditions are reflected in the distribution of spontaneous plants in public gardens, which are characterized by a forte representation of therophytes and geophytes. Application of Correspondence Analysis to the data described the ecological gradients responsible for the distribution of these taxa. These gradients correspond to the following ecological factors: Humidity, and organic matter. These gardens constitute a favorable

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environment for the installation and development of spontaneous plants that have various importances.

5. REFERENCES

Abdelguerfi, A., Laouar, M. (1999). Autoécologie et variabilité de quelques légumineuses d'intérêt fourrager et/ou pastoral: possibilités de valorisation en région méditerranéenne [Autoecology and variability of some legumes of forage and/or pastoral interest: development possibilities in the Mediterranean region]. *Pastagens e Forragens, 20*, 81-112.

Abdi, H., Williams, L. J. (2010). Principal component analysis. *Wiley interdisciplinary reviews: computational statistics*, *2(4)*, 433-459. https://doi.org/10.1002/wics.101

Alfudhala, S.M. (2009). On the Urban Ecology of Kuwait: Structure and Function of Public Gardens. Master Thesis. Dalhousie University, Canada. 61 p.

Al-Yemeny, M. N. (1999). A check list of weeds in Al-kharj area of Saudi Arabia. *Pakistan Journal of Biological Science*, *2(1)*, 7-13. https://dx.doi.org/10.3923/pjbs.1999.7.13

Balah, M. A. A. (2019). Weeds flora demographic analysis of date palm orchards in El-Bahariya, El-Frafra and Siwa Oases. *Acta Ecologica Sinica*, *39(1)*, 14-20. https://doi.org/10.1016/j.chnaes.2018.07.002

Bensizerara, D., Chenchouni, H., Bachir, A.S., Houhamdi, M. (2013). Ecological status interactions for assessing bird diversity in relation to a heterogeneous landscape structure. *Avian Biology Research*, *6 (1)*, 67-77. https://doi.org/10.3184%2F175815513X13577344603957

Bouallala, M. (2013). Etude floristique et nutritive spatio-temporelle des parcours camelins du Sahara Occidental Algérien. Cas des régions de Bechar et Tindouf [Spatio-temporal floristic and nutritive study of camel rangelands in Algerian Western Sahara. Case of Bechar and Tindouf regions]. Thèse Doctorat Es Sciences, Université d'Ouargla. 208 p.

Bouallala, M., Neffar, S., Chenchouni, H. (2020). Vegetation traits are accurate indicators of how do plants beat the heat in drylands: Diversity and functional traits of vegetation associated with water towers in the Sahara Desert. *Ecological Indicators*, *114*, 106364. https://doi.org/10.1016/j.ecolind.2020.106364

Bossu, A., Bertaudière-Montès, V., Marco, A. (2011). Évolution comparée de la flore des jardins privatifs d'un village du Luberon (Lauris, Vaucluse) et de Marseille (Bouches-du-Rhône). [comparative evolution between privates gardens' flora of a Luberon village (Lauris, Vaucluse) and Marseille (bouchesdu-rhône)]. *Courrier scientifique du Parc naturel régional du Luberon et de la Réserve de biosphère Luberon-Lure. 10*, 74-91. http://hdl.handle.net/2042/58131

Bossu, A., Manel, S., Marco, A., Carrère, M., Bertaudière-Montès, V. (2014). Composition spécifique et fonctionnelle comparée de la flore spontanée des jardins privatifs d'un village du Luberon (Lauris, Vaucluse) et d'une grande agglomération (Marseille, Bouches-du-Rhône) [Species and functional composition of spontaneous flora in private gardens, a comparison between a Luberon village (Lauris, Vaucluse) and a large city (Marseille, Bouches-du-Rhône)]. *Courrier scientifique du Parc naturel régional du Luberon et de la Réserve de biosphère Luberon-Lure*, *12*, 88-106. http://hdl.handle.net/2042/58154

Bradai, L., Bouallala, M., Bouziane, N.F., Zaoui, S., Neffar, S., Chenchouni, H. (2015). An appraisal of eremophyte diversity and plant traits in a rocky desert of the Sahara. *Folia Geobotanica, 50(3)*, 239-252. https://doi.org/10.1007/s12224-015-9218-8

Caixinhas, M.L., Liberato, M.C. (1995). Flore de la Macaronésie aux parcs et jardins botaniques de Lisboa [Flora of Macaronesie in botanical gardens and parks of Lisboa]. Procedding of the 1 st symposium Fauna & Flora of the Atlantic Islands.175-180.

Chenchouni, H. (2012). Diversité floristique d'un lac du bas-sahara algérien. [Flora Diversity of a Lake at Algerian Low-Sahara]. *Acta Botanica Malacitana*, *37*, 33-44. https://doi.org/10.24310/abm.v37i0.2664

Chindyaeva, L.N., Belanova, A.P., Kiseleva, T.I. (2018). Patterns of natural regeneration of alien species of woody plants in Novosibirsk. *Russian Journal of Biological Invasions. 9(3)*, 273-285. https://doi.org/10.1134/S2075111718030025

Dhileepan, K. (2014). Prospects for the classical biological control of *Calotropis procera* (Apocynaceae) using coevolved insects. *Biocontrol Science and Technology*, *24(9)*, 977-998. http://dx.doi.org/10.1080/09583157.2014.912611

El-Ghanim, W.M., Hassan, L.M., Galal, T.M., Badr, A. (2010). Floristic composition and vegetation analysis in Hail region north of central Saudi Arabia. *Saudi Journal of Biological Sciences*, *17(2)*, 119-128. https://doi.org/10.1016/j.sjbs.2010.02.004

*Corresponding author, E-mail address: Souddi01@hotmail.com

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
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Current Trends in Natural Sciences (CD-Rom)
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ISSN-L: 2284-9521

Elimam, A. M., Elmalik, K. H., Ali, F. S. (2009). Efficacy of leaves extract of *Calotropis procera* Ait.(Asclepiadaceae) in controlling Anopheles arabiensis and Culex quinquefasciatus mosquitoes. *Saudi journal of biological sciences*, *16*(2), 95-100. https://doi.org/10.1016/j.sjbs.2009.10.007

El-Saied, A.B., El-Ghamry, A., Khafagi, O.M.A., Powell, O., Bedair, R. (2015). Floristic diversity and vegetation analysis of Siwa Oasis: an ancient agro-ecosystem in Egypt's Western Desert. *Annals of Agricultural Sciences, 60(2)*, 361-372. https://doi.org/10.1016/j.aoas.2015.10.010.

FAO. (2011). The state of the world's land and water resources for food and agriculture. Food and Agriculture Organization, Abingdon.

Faurie, C., Ferra, Ch., Medori, P., Dévaux, J., Hemptinne, J.L. (2003). Ecology: Scientific and practical approach. Tec & Doc, Lavoisier. Paris. 407 p.

Flores, P.M.C., Fernandez, A.I., Orozco, K.J.U., Endino, R.M.C., Picardal, J.P., Garces, J.J.C. (2020). Ornamental plant diversity, richness and composition in urban parks: studies in Metro Cebu, Philippines. *Environmental and Experimental Biology*, *18*, 183-192. http://doi.org/10.22364/eeb.18.19.

Garces J.J., Flores M. J.L. (2017). Effects of environmental factors and alien plant invasion on native floral diversity in Mt. Manunggal, Cebu Island, Philippines. *Current World Environment*, *13(3)*, 390-402. http://dx.doi.org/10.12944/CWE.13.3.12

Ghahremaninejad, F., Hoseini, E., Fereidounfar, S. (2021). Cities in drylands as artificial protected areas for plants. *Biodiversity and Conservation*, *30(1)*, 243-248. https://doi.org/10.1007/s10531-020-02079-2.

Godron, M. (1974). Vocabulaire d'écologie [Vocabulary of ecology]. Ed. Hachette, Paris. 273 p.

Gounot, N. (1969) Méthodes d'études quantitatives de la végétation [Methods of quantitative studies of vegetation]. Ed.Masson, Paris. 314 p.

Hope, D., Gries, C., Zhu, W., Fagan, W. F., Redman, C. L., Grimm, N. B., Nelson, A. L., Martin, C., Kinzig, A. (2003). Socioeconomics drive urban plant diversity. *Proceedings of the national academy of sciences*, *100*(15), 8788-8792. https://doi.org/10.1073/pnas.1537557100

Jolliffe, I. T. (1986). Principal component analysis. Springer, New York, 488 p.

Kouamé, A.S., Bakayoko, G.A., Kouamé, K.F., Ipou Ipou, J., N'guessan, K.E. (2017). Flore adventice des cultures vivrières de la zone périurbaine du district d'Abidjan (Côte d'Ivoire). [Weed flora of food crops in the peri-urban area of Abidjan district (Côte d'Ivoire)]. *Journal of applied Biosciences*, *118*, 11744-11753. https://dx.doi.org/10.4314/jab.v118i1.1

Knevel, I. C., Lubke, R. A. (2005). Reproductive phenology of Scaevola plumieri; a key coloniser of the coastal foredunes of South Africa. *Plant Ecology*, *175(1)*, 137-145. https://doi.org/10.1007/s11258-004-3369-7

Kuras, E.R., Warren, P.S., Zinda, J.A., Aronson, M.F., Cilliers, S., Goddard, M.A., Nilon, C.H., Winkler, R. (2020). Urban socioeconomic inequality and biodiversity often converge, but not always: A global meta-analysis. *Landscape and Urban Planning*, *198*, 103799. https://doi.org/10.1016/j.landurbplan.2020.103799.

Le Bourgeois, T., Marnotte, P. (2002). Modifier les itinéraires techniques : la lutte contre les mauvaises herbes. [Modify the technical itineraries: weed control]. In: Memento of the agronomist. CIRAD, Montpellier, France, Pp. 663-684.

Le Houérou, HN. (1992). An overview of vegetation and land degradation in world arid lands. In: Degradation and restoration of arid lands: Dregne, H.E., eds., International Center for semi-arid land studies, Texas Technical University, Lubbock, 127-63

Liendo, D., García-Mijangos, I., Biurrun, I., & Campos, J. A. (2021). Annual weedy species of Erigeron in the northern Iberian Peninsula: a review. *Mediterranean Botany*, *42*, e67649. https://doi.org/10.5209/mbot.67649

Lundholm, J. T., Richardson, P. J. (2010). MINI REVIEW: Habitat analogues for reconciliation ecology in urban and industrial environments. *Journal of Applied Ecology*, *47(5)*, 966-975. https://doi.org/10.1111/j.1365-2664.2010.01857.x

Marco, A., Dutoit, T., Deschamps-Cottin, M., Mauffrey, J. F., Vennetier, M., Bertaudière-Montes, V. (2008). Gardens in urbanizing rural areas reveal an unexpected floral diversity related to housing density. *Comptes Rendus Biologies*, *331(6)*, 452-465. https://doi.org/10.1016/j.crvi.2008.03.007

Marco, A., Bertaudière-Montès, V., Deschamps-Cottin, M., Mauffrey, J. F., Vennetier, M., Dutoit, T. (2010). Diversité de la flore cultivée des jardins privés du Parc naturel régional du Luberon : le cas de la commune de Lauris (Vaucluse). [Artificial floristic diversity of private gardens in the natural regional park of Luberon: the case of Lauris village (Vaucluse)]. *Courrier scientifique du Parc naturel régional du Lubéron et de la réserve de biosphère Luberon-Lure*, *9*, 38-57. http://hdl.handle.net/2042/58116

*Corresponding author, E-mail address: Souddi01@hotmail.com

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Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

Montégut, J. (1983). Perennials and perennials in North Africa. In Symposium on weed science in Algeria, Algiers, pp. 5-33.

Nègre, R. (1961-1962). Petite flore des régions arides et semi-arides du Marc occidental. Edition du Centre National de la Recherche Scientifique [Small flora of the arid and semi-arid regions of western Morocco]. Paris: Ed. C.N.R.S. Tomes I et II, 279p.

Ohba, H., Amirouche, R. 2003. Observation of the Flora of Tadmait and Tidikelt, Central Sahara, Algeria. *Journal of Japanese Botany*, *78(2)*, 104-11.

Ozenda, P. (2004). Flore et végétation du Sahara. Edition du Centre National de la Recherche Scientifique [Flora and vegetation of Sahara]. Paris: Ed. C.N.R.S. 665 p.

Piélou, E. C. (1966). Species diversity and pattern diversity in the study of ecological succession. *Journal of theoretical biology*, *10*(2), 370-383. https://doi.org/10.1016/0022-5193(66)90133-0

Picardal, J. P., Avila, S. T. R., Tano, M. F., & Marababol, M. S. (2011). The species composition and associated fauna of the mangrove forest in Tabuk and Cabgan Islets, Palompon Leyte, Philippines. *CNU Journal of Higher Education*, *5*, 1-18.

Quézel, P., Santa, S. (1962-1963). Nouvelle flore d'Algérie et des régions désertiques méridionales. Edition du Centre National de la Recherche Scientifique [New flora of Algeria and southern desert regions]. Paris: Ed. C.N.R.S. 2 Vol, 1170p.

Quézel, P. 1965. La végétation du Sahara du Tchad à la Mauritanie [The vegetation of Sahara from Tchad to Mauritania]. Paris: Ed. Masson. 333 p.

Rana, T.S., Datt, B., Rao, R.R. (2001). Vegetational diversity in Tons Valley, Garhwal Himalaya (Uttaranchal) India with special reference to phytogeographical affinities of the flora. *Taiwania*, *46(3)*, 217-231.

Raunkiaer, C. (1934). The life forms of plants and statistical plant geography. Oxford: Clarendon Press, London, UK, 632 p.

Shannon, C.E., Weaver, W. (1949). The mathematical theory of communications. Urbana: Univ. Illinois Press, 117 p.

Shmida, A., Evenari, M., Noy-Meir, I. (1986). Hot desert ecosystems: an integrated view. In: Evenari M, Noy-Meir I, Goodall DW (eds). *Ecosystems of the World, 12b. Hot Deserts and Arid Shrublands*. Elsevier, Amsterdam, pp 379-387

Shochat, E., Warren, P. S., Faeth, S. H., McIntyre, N. E., & Hope, D. (2006). From patterns to emerging processes in mechanistic urban ecology. *Trends in ecology & evolution*, *21(4)*, 186-191. https://doi.org/10.1016/j.tree.2005.11.019

Sørensen, T.A. (1948). A method of establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation on Danish commons. *Biologiske Skrifter*. *5*, 1-34.

Souddi, M., Bouallala, M. (2021). Biodiversity of trees and shrubs of urban plantations in arid regions. *Current Trends in Natural Sciences*, *10(20)*, 147-156. https://doi.org/10.47068/ctns.2021.v10i20.020.

Souleymane, D., Aubin, D., Grévin, A.A.J, Ali, M., Adama, B. (2018). Flore Adventices des jardins potagers des établissements pénitentiaires de Côte d'Ivoire: Cas des maisons d'Arrêt et de correction d'Abidjan et de Gagnoa. [Flora Weeds of vegetables gardens Penitentiary institutions of Ivory Coast: Cases of Abidjan and Gagnoa]. *European Scientific Journal*, *14*, 550-570. http://dx.doi.org/10.19044/esj.2018.v14n36p550

Taleb, A., Bouhache, M., Rzozi, S. B. (1998). Flore adventice des céréales d'automne au Maroc [Weeds of small grain in Morocco]. *Revue Marocaine des Sciences Agronomiques et Vétérinaires*, *18(2)*, 121-130.

Tam, K. C., Bonebrake, T. C. (2016). Butterfly diversity, habitat and vegetation usage in Hong Kong urban parks. *Urban ecosystems*, *19 (2)*, 721-733. https://doi.org/10.1007/s11252-015-0484-2

Traoré, K., Soro, D., Pene, C. B., Ake, S. (2010). Flore adventice sous palmeraie, dans la zone de savane incluse a Dabou, basse Côte d'Ivoire. [weeds in dabou oil- palm ochards in included - savanah areas of southern Ivory Coast]. *Agronomie Africaine*, *22(1)*, 21-32. https://doi.org/10.4314/aga.v22i1.62313

Valenzuela, H.Y., Bacalso, A.D., Gano, C.B., Pilones, K.D., Picardal, J.P. (2013). The species composition and associated flora and fauna of the mangrove forest in Badian, Cebu Island, Philippines. *International Journal of Marine Ecology*, 1, 1-23. http://dx.doi.org/10.7718/iamure.ijme.v1i1.342

Van der Pijl, L. (1982). Principles of dispersal in higher plants. Springer, Berlin, Heidelber. New York. 218 p.

Verdeguer, M., Castañeda, L. G., Torres-Pagan, N., Llorens-Molina, J. A., & Carrubba, A. (2020). Control of Erigeron bonariensis with Thymbra capitata, Mentha piperita, Eucalyptus camaldulensis, and Santolina chamaecyparissus essential oils. *Molecules*, *25(3)*, 562. https://doi.org/10.3390/molecules25030562

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