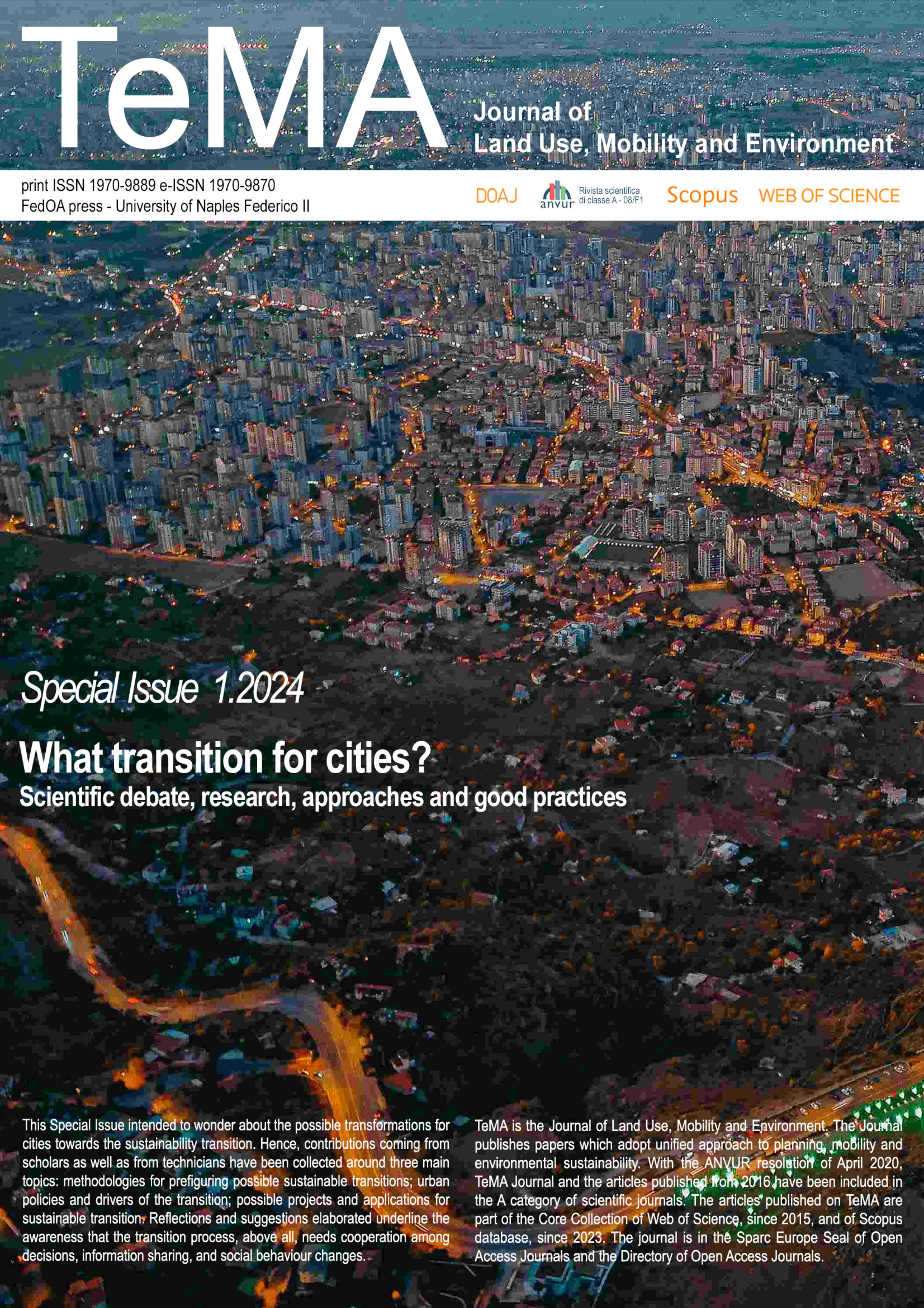

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Special Issue 1.2024

What transition for cities?

Scientific debate, research, approaches and good practices

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Contributions of native plants to the urban ecosystem: Bursa (Turkey) sample

Native plants in urban ecosystem

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Abstract

In the coming years, it is a potential danger that the ecosystems existing in urban areas will be heavily affected, especially under the pressure of climate change. In the face of this danger, a good understanding of the natural landscape in urban areas and the adoption of local species are of great importance for sustainability. Native plants contribute to the life of their communities by quickly adapting to the environmental conditions in their areas. In this study, the contributions of 72 native woody taxa to the ecosystem were investigated in Bursa (Turkey), which has a rich flora. The relationships that emerged in terms of the criteria examined revealed essential results. The existence of some relationships between the criteria found in the study, like "significant positive correlation was determined at the 5% level between bee attraction and erosion prevention or negative correlation at the 5% level with bee attraction and water demand", shows that the use of native plants is vital for the protection of the ecosystem in urban areas. The primary purpose is to examine the ecological needs of native plants and their contribution to urban ecology to determine whether the existing correlation relationships are meaningful. It is aimed to associate natural areas in cities with the ecological needs of plants.

Keywords

Native plants; Sustainability; Urban ecosystem

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1. Introduction

With the discovery of agriculture in the Neolithic period, the first activities of people on changing nature began, and in this context, planting seeds of plants, taming animals, settling in certain places, and building houses were seen as the first examples of landscaping.

The fact that people started to change the landscape through agriculture has led to the emergence of limited nature destruction (Gül, 2000). It is seen that the "Natural Landscape," which has effects from the Stone Age to the present, has decreased with destruction from prehistoric times to the present (Akurgal, 1998). In the following processes, factors such as rapid population growth, the emergence of the Industrial Revolution, and urbanization caused a rapid increase in the interventions to the natural landscape, which accelerated environmental pollution and started to affect ecosystems negatively.

Due to these negativities that have arisen today, people all over the world have begun to worry about "denaturalizing," that is, breaking away from nature or disappearing (Gül, 2000). In order to address these and similar concerns, Miller, Simonds, and other researchers suggested 100 years ago that the use of native plants in the landscape is a good option, the evaluation of natural conditions in the natural landscape, the realization of "naturalistic" arrangements based on the recreation of nature rather than artificial arrangements in the design approach.

Wilheim Miller, working at the University of Illinois in 1912, published his work called "Designing in the Prairie Spirit" as a series of articles and gave information about the use of native plants in residential gardens, agriculture, parks, roadside design, and rural restoration.

One of the first practitioners of Miller's ideas was landscape architect Ossian C. Simonds, who worked in Chicago (SNR, 2011).

Parallel to these developments, attempts to minimize human intervention and control in landscape design and applications have increased rapidly. The increase in non-native species is unintentionally or intentionally associated with human activities (Richardson et al., 2000; Garcillan and Martorell, 2021).

In particular, natural landscape design and applications, which envisage the promotion of wildlife in cities and the increase of natural areas depending on ecological principles, have started to become popular in Europe and America (Özgüner, 2003).According to Kendle and Forbes (1997), low-cost sustainable landscapes can be created with the natural landscape style, the real meaning of the landscape can be reflected, a significant contrast to the classical style design experiences can be achieved, the value of the area in terms of environmental protection, environmental education, and recreational use can be increased, the public landscape can be valued.

This natural landscape style is characterized by diversity of species, structural complexity in plant communities, absence of uniform structure, maximum use of natural elements, especially native species, minimal use of artificial elements and exotic species, minimal human influence in design and implementation, and environmental control. It has begun to be adopted by many of the modern landscape designers and planners who argue that it should be limited (Özgüner, 2003).

The common point of the studies on the ecosystem integrity of natural vegetation, its contribution to biodiversity, and its contribution to ensuring habitat continuity is the threat posed to biodiversity by habitat fragmentation. This threat reveals the necessity of maintaining ecosystem balance and continuity, creating corridors that will allow transitions between natural vegetation and urban landscape, and disseminating the use of more intense native plant species in urban areas (Deniz and Şirin, 2005; Bianconi et al., 2018).

This situation is extremely important for sustainable plant designs, defined as "planting or vegetation management that preserves and maintains ecological integrity, encourages the use of native opportunities for plant resources and species selection, and foresees the use of minimum energy and physical resources in production." The basis of this approach is closely related to resource protection and management.

The use of native plants in this process is considered more appropriate with considerations such as "the native species' adaptation to the terrain and climatic conditions of the region, providing shelter for many animal species, and their successful performance in problematic areas" (Dunnet and Hitchmough, 1996; Kennedy and Southwood, 1994; Özgüner, 2003).

On the other hand, securing their lives in urban areas where insects and animals have to live as vulnerable to human interactions along with their housing problems requires excellent efforts. However, despite the challenges of existing in urban environments, many wildlife species have adapted to these systems.

It is crucial to understand the natural landscape better and to adopt native species in order to make ecosystems sustainable in urban areas without breaking the chain of life (Flyger, 1974; Atkinson and Shackleton, 1991; Quinn, 1992; Gliwicz et al., 1994; Gustafson, 1998; Burger et al., 2004; Parker and Nilon, 2008; Parker and Nilon, 2012) this is also a critical tool for habitat identification and conservation of wildlife species (Johnson, 1995; Clergeau et al., 1998; Livingston et al., 2003).

Native plants are in mutual interaction with all physical and biotic factors in the areas where they are found, effortlessly adapting to environmental conditions, contributing to the life of natural living communities, requiring less care, being a source of shelter and food for wildlife, landscaping, protection and restoration projects. It also has many features, such as being among the significant alternative sources (Barış, 2002; Deniz and Şirin, 2005; Çorbacı et al., 2017; Eroğlu 2010).

In addition to these contributions, exotic plant species contribute almost nothing to the food web (Anonymous, 2019).

However, the existence of natural vegetation has unlimited direct and indirect benefits to the country's economy.

It is a resource for improving the climatic conditions of a country and preventing soil loss in other rural areas, laying the groundwork for scientific research, and meeting the raw material and fuel needs of forest products, food, and pharmaceutical industry units (Cengiz, 2001).

The use of natural vegetation samples in landscape architecture works is an application that is compatible with ecological, economic, and aesthetic conditions, as well as a landscape design in harmony with nature (Akdoğan, 1972; Atik and Karagüzel, 2007; Altunkasa et al., 2017).

In designs, With the use of native plants, ecological benefits such as protecting biological diversity, providing a habitat for wildlife species, and creating a healthy plant tissue, economic benefits such as reducing fertilization, spraying, and irrigation needs and costs, and aesthetic benefits such as improving environmental quality are provided (Slattery et al., 2003; Atik and Karagüzel, 2007).

In this study, native woody plant taxa in the flora of Bursa province were examined, and their contributions to the ecosystem were tried to be revealed.

As can be expected, many studies have been conducted on natural plants and the aesthetic and ecological properties of plants, and the above examples have been selected only as examples and support for those included in our study. However, there are very few studies in the literature where aesthetic and ecological properties are evaluated simultaneously on natural plants.

In addition, the study area has been determined so that many natural plants with different needs can coexist at the same time.

The aim was to take advantage of both the evaluated features and the ability of the area to provide different geographical and climatic conditions simultaneously.

In this way, the information produced by this study conducted in a specific location will be available to researchers from all over the world.

2. Material and Methods

2.1 Material

The woody taxa (tab. 1), which are found naturally in the flora of Bursa and evaluated as landscape plants and also have the potential to be evaluated by Zencirkıran (2004), Zencirkıran (2009), were utilized as study material.

1. Pinus pinea L.
2. Pinus brutia Henry.
3. Pinus nigra Arn. ssp. pallasiana (Lamb.) Holmboe.
4. Pinus silvestris L.
5. Abies nordmanniana (Stev.)Spach ssp. bornmülleriana Mattf.
6. Juniperus communis ssp. Nana
7. Juniperus oxycedrus L.
8. Juniperus excelsa L.
9. Taxus baccata L.
10. Acer campestre L.
11. Acer platanoides L.
12. Pistacia terebinthus L.
13. Rhus coriaria L.
14. Alnus glutinosa L. Gaertn.
15. Carpinus betulus L.
16. Coryllus avellana L.
17. Cornus mas L.
18. Cornus sanguinea L. subsp. sanguinea
19. Arbutus unedo L.
20. Arbutus andrachne L.
21. Erica arborea L.
22. Vaccinium myrtillus L.
23. Vaccinium uliginosum L.
24. Vaccinium arctostaphyllos L.
25. Fagus orientalis
26. Castanea sativa Mill.
27. Quercus robur L. ssp.robur
28. Quercus frainetto Ten.
29. Quercus petraea (Mattuschka) Liebl. ssp. iberica (Steven ex Bieb.)
30. Quercus hartwissiana Stev infectoria Olivier ssp. nfectoria (Reut) Schwarz.
31. Quercus pubescens Wild.
32. Quercus ithaburensis
33. Quercus trojana P.B. Webb.
34. Quercus coccifera L.
35. Quercus hartwissiana Stev.
36. Laurus nobilis L.
37. Fraxinus ornus L.
38. Olea europaea L.
39. Jasminum fruticans L.
40. Phillyrea latifolia L.
41. Platanus orientalis L.
42. Salix caprea L.
43. Salix cinerea L.
44. Salix amplexicaulis L.
45. Populus alba L
46. Populus tremula L.
47. Ulmus glabra L.
48. Celtis australis L.
49. Tilia argentea Desf.ex.DC.
50. Tamarix parviflora DC.
51. Cercis siliquastrum L.
52. Spartium junceum L.
53. Chamaecytisus hirsutus (L.) Link.
54. Chamaecytisus austriacus (L.) Link.
55. Chamaecytisus pygmaeus (Willd) Rothm.
56. Vitex agnus-castus L.
57. Hedera helix L.
58. Daphne oleoides Schreber
59. Daphne pontica L.
60. Daphne sericea L.
61. Cistus laurifolius L.
62. Cistus salviifolius L.
63. Cistus creticus L.
64. Euonymous europaeus L.
65. Pyracantha coccinea M.J.Roem.
66. Rosa gallica L.
67. Rosa canina L.
68. Clematis viticella L.
69. Clematis cirrhosa L.
70. Ruscus aculeatus L.
71. Styrax officinalis L.
72. Viburnum tinus L.

Tab.1 Native woody taxa evaluated as research material

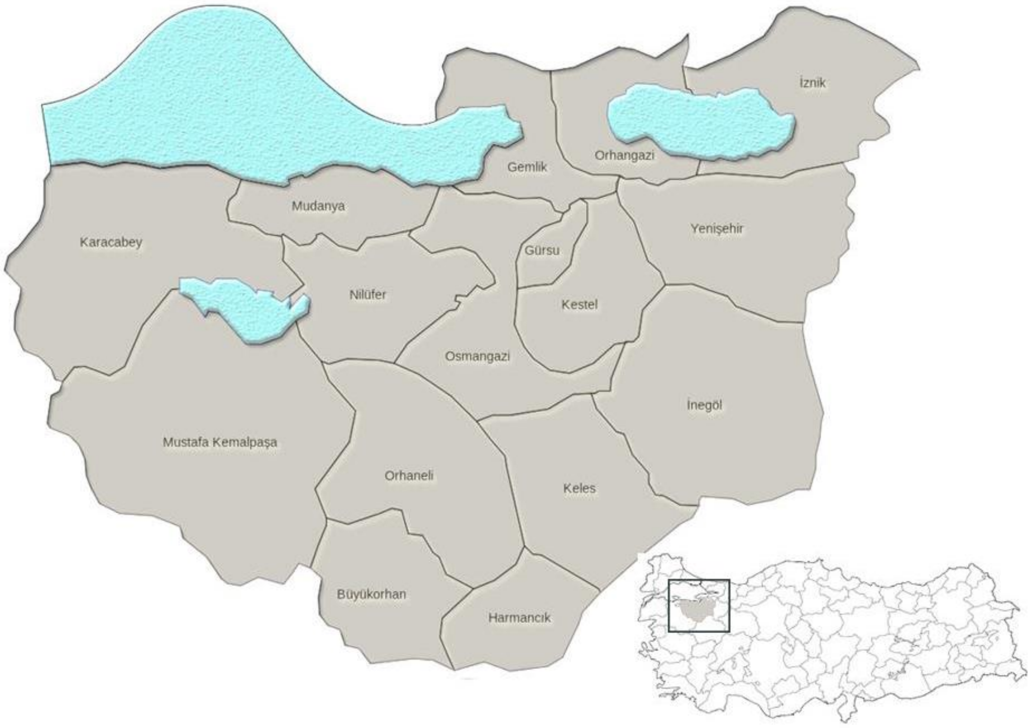

Fig.1 Location of the study area

Bursa, chosen as the study area and the fourth largest city of Turkey in terms of population, is located in the south of the Marmara Region, between 39° 30'-40° 37' north latitudes and 28° 06'-29° 58' east longitudes. It is surrounded by Bilecik and Sakarya in the east, Kocaeli, Yalova, Istanbul, and the Marmara Sea in the north, Kütahya in the south, and Balıkesir in the west (fig. 1) (Zencirkıran et al., 2019). Uludag, which has an altitude of 2543 m and hosts extremely important plant taxa, is located within the borders of Bursa province. On the northwest skirts of Uludağ is the Bursa Plain, where the city spreads. The hottest months of the city are July - August, and the coldest months are February and March. The annual total precipitation is 736.1 mm, and the average relative humidity is around 69%. The Mediterranean climate is dominant in Bursa, which has a coast to the Marmara Sea, with warm and dry summers and mild and rainy winters. Move away from the sea, a semi-terrestrial climate is observed in the interior (Korukçu and Arıcı, 1986; Zencirkıran, 2004; Ender and Zencirkıran, 2017; Zencirkıran et al. 2019).The critical factor in choosing the research area is that it has very different geographical and climatic features. The region includes elevations above 2500 meters, along with areas at sea level. Likewise, although the Mediterranean climate is predominant, examples of mountain climates and semi-terrestrial areas are also encountered in the research area. This ensures that the results of research in the field can be evaluated without being limited to the local area.

2.2 Method

One of the most important criteria taken into consideration when creating the idea of the study was to bring together different perspectives of looking at natural plants.

Therefore, a hypothesis was created that would use as much of the ecological and aesthetic properties of natural plants as possible. However, in the hypothetical preliminary evaluations, some of these factors were eliminated, and a more target-oriented approach was adopted. While doing this, it was also aimed to create a more innovative data set for future research by using features that have yet to be evaluated together in the literature so far.

Using sources such as Davis (1965-1985), Dirr (1998), Hillier (1998), Zencirkıran (2004), Native and Adapted Landscape Plants (2009), Zencirkıran (2009), Gardening with Native Plants (2012), Native Plants for your Landscape (2012), Zencirkıran (2013), Sarah et al. (2014), Florida-Friendly Landscaping™ Guide (2015), Zencirkıran et al. (2019) Akkemik (2020), Mamıkoğlu (2020) the criteria of taxa under the headings of "contributions to the ecosystem" and "ecological demands" were put forward.

The contributions of taxa to the ecosystem were evaluated within the scope of ecological criteria (creation of natural habitat (shelter), a food source for animals, a food source for humans, butterfly attraction, bee attraction (pollination), erosion prevention) and aesthetic criteria (autumn coloration, flowering period, form. Ecological demands of taxa were examined under the headings of water, soil, and light demands.

All data obtained were evaluated using the SPSS 22 for Windows package program (I.B.M. Corp Released 2013). Pearson correlation analysis was performed in order to determine the direction and strength of the relationships that may exist between the criteria (Miles and Banyard, 2007; Öztuna et al., 2008; Choi et al., 2010; Sheskin, 2011). Since all plants have the ability to create a natural habitat (shelter), the criterion of shelter was excluded, considering that it would prevent a statistically significant result in terms of relations between criteria. On the other hand, flower colors were not taken into consideration, considering that misleading results could be obtained regarding bees within the scope of the situations presented by some researchers such as Parker et al. (1987), Arbuckle et al. (2001), Willmer, and Stone (2004); Willmer (2011), Lunau et al. (1996), Spaethe et al. (2001), Manning (1956), Free (1970), Waser and Price (1985), Dafni and Giurfa (1999), Lunau (2000), Lunau, (2006), Hempel de Ibarra and Vorobyev (2009).

3. Findings

Within the scope of the research, it was determined that 38.9% of the 72 woody taxa naturally found and evaluated in Bursa flora were evergreen, and 61.1% were deciduous taxa. It was determined that 42% of the taxa had moderate water demand, 51% clayey-sandy-loam soil demand, and 51% were suitable to be kept in sun-half shade environments (Figures 2, 3, and 4).

Figure 2 shows the water demands of the taxa. The highest rate in these taxa is medium (42%). The lowest rate is high (4%) water demand.

In Figure 3, the highest soil demand rate (51%) is sandy clay loam. The lowest proportions are loam (4%) and sandy (5%).

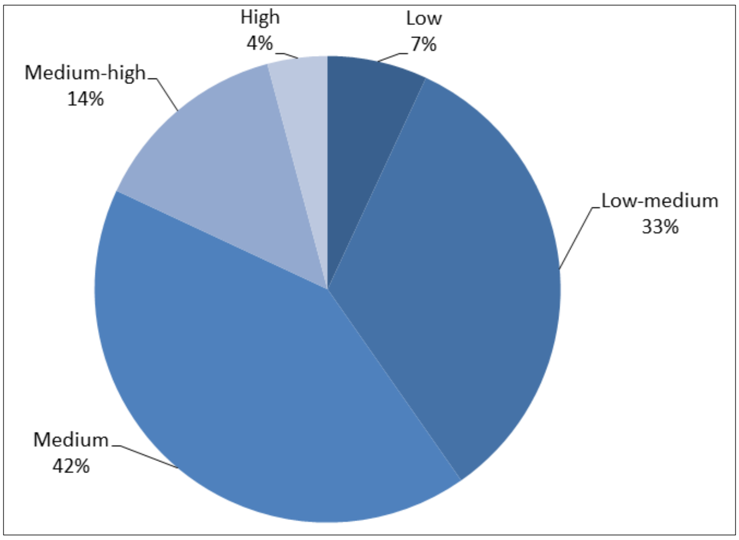

Fig.2 Distribution of the taxa according to their water demands

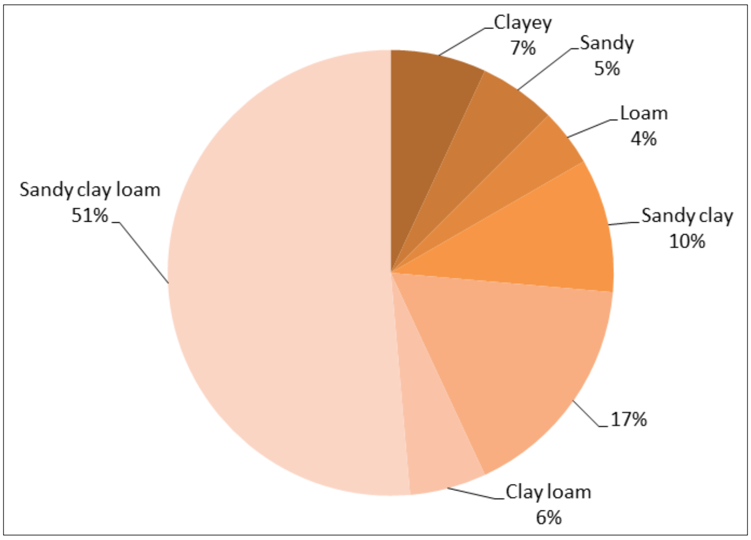

Fig.3 Distribution of the taxa according to their soil demands

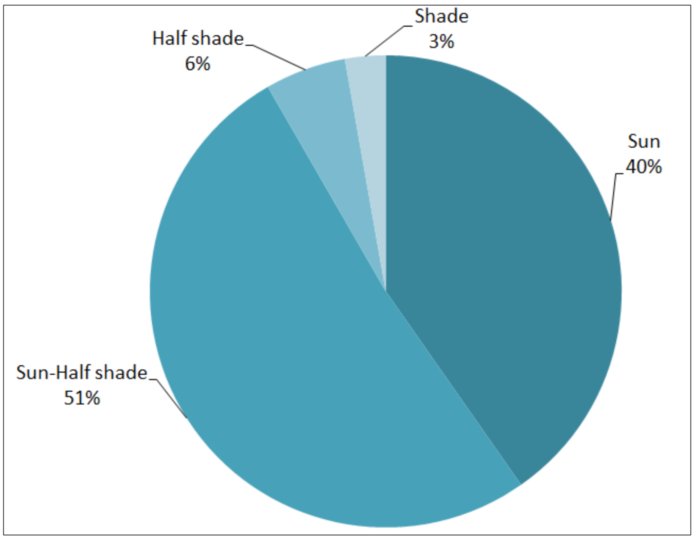

Fig.4 Distribution of the taxa according to their light demands

		Ecological Criteria					Aesthetic Criteria
		Food source for animals	Food source for humans	Butterfly Attraction	Bee Attraction	Erosion Prevention	Autumn coloration
Number	+[*]	29	19	29	44	36	16
	-	43	53	43	28	36	56
Percent	+	40,3%	26,4%	40,3%	61,1%	50,0%	22,2%
	-	59,7%	73,6%	59,7%	38,9%	50,0%	77,8%

[*] If the criterion is present in plants, it is +; if it is not - it is.

Tab.2 Distribution of taxa according to ecological and aesthetic criteria

Figure 4 shows the light demands of the taxa. The highest rate in these taxa is sun-half shade (51%). The lowest rate is shade (3%).

Table 2 shows that half of the taxa provide erosion prevention, and more than half attract bees. It has been determined that 19 species are food sources for humans, and 29 species are for animals. Autumn coloration as an aesthetic criterion is seen in 16 taxa.

The findings of the ecological and aesthetic criteria examined in terms of the contribution of taxa to the ecosystem are given in Table 2 and Figures 5 and 6.

In Figure 5, the highest flowering times proportions are one month of flowering (15%) and three months of flowering (15%). The lowest rate is nine months of flowering (1%). The form characters of the taxa are given in Figure 6. Taxa with rounded irregular shapes are the most numerous. The most minor form character is weeping. The mean values and standard deviations of the criteria are given in Table 3, and the relations between the criteria are given in Table 4 as a result of the correlation analyses made in terms of the dendrological characteristics and ecological demands of the taxa and their contributions to the ecosystem within the framework of ecological and aesthetic criteria.

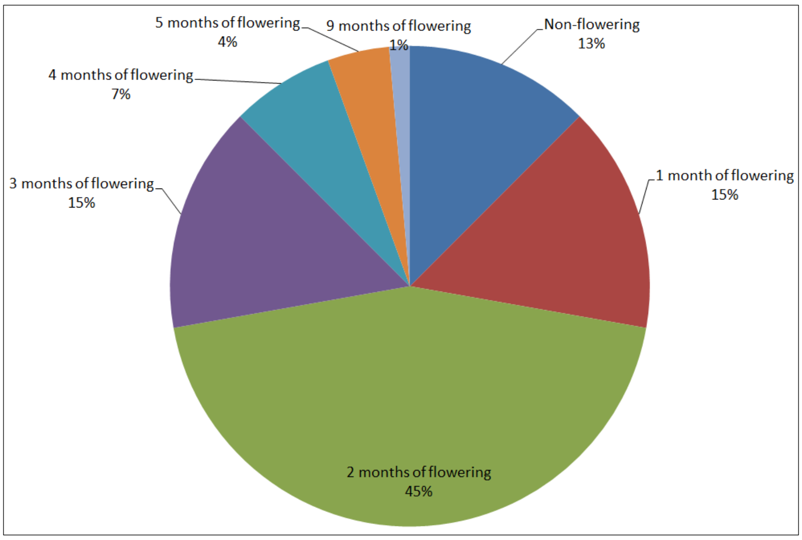

Fig.5 Distribution of the taxa according to their flowering times

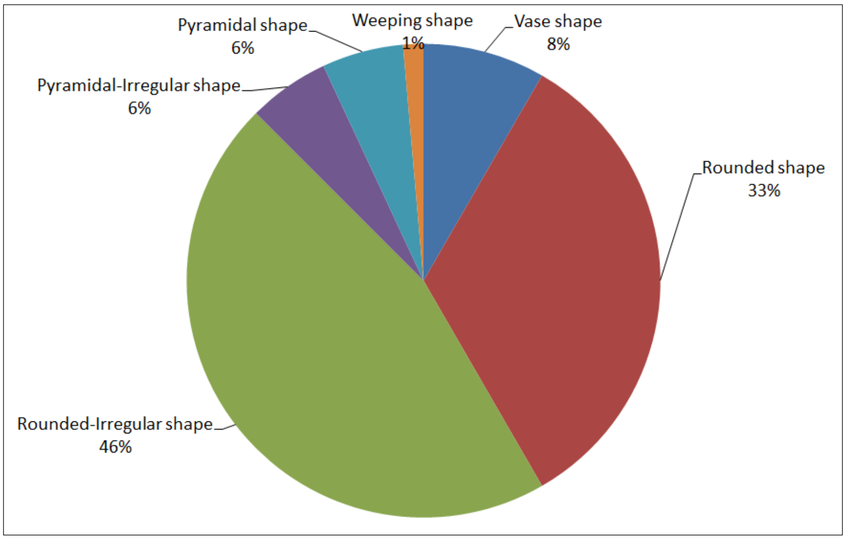

Fig.6 Distribution of the taxa according to their form characteristics

Criterion	Mean	Std.Deviations	Total
Leaf Characteristic	1,61	0,491	72
Water Demand	2,75	0,931	72
Soil Demand	3,38	1,347	72
Light Demand	1,71	0,701	72
Food Source for Animals	0,40	0,494	72
Food Source for Humans	0,26	0,444	72
Butterfly Attraction	0,40	0,494	72
Bee Attraction	0,61	0,491	72
Erosion Prevention	0,50	0,504	72
Autumn Coloration	0,22	0,419	72
Flowering Period	2,11	1,469	72
Form	2,71	0,999	72

Tab.3 The mean values and standard deviations of the criteria

A significant positive correlation was determined at the level of 1% between the leaf characteristics of taxa and their water demands. Also, 1% significant positive correlation was determined between the leaf characteristics of the taxa and the autumn coloration, a significant positive correlation at the level of 5% between the water demand and soil demand of taxa, significant negative at the level of 1% between soil demand and erosion prevention, significant negative at the level of 1% between soil demand and bee attraction feature, 1% significant positive correlation between being a food source for animals and a food source for humans and flowering period, significant positive correlation at the level of 5% between being a source of food for animals and bee attraction, 1% significant positive correlation between being a food source for humans and attracting butterflies and there is significant positive correlation at the 5% level between bee attraction. A 1% positive correlation was determined between attracting butterflies and attracting bees and also between butterfly attraction and flowering time. There is a 1% significant positive between bee attraction and flowering time. A significant positive correlation was determined at the 5% level between bee attraction and erosion prevention. There is a significant negative correlation at the 5% level with bee attraction and water demand. On the other hand, a significant negative correlation at the level of 5% was determined between bee attraction and form.

Criteria	**Water Demand**	**Soil Demand**	**Light Demand**	**Food Source for Animals**	**Food Source for Humans**	**Butterfly Attraction**	**Bee Attraction**	**Erosion Prevention**	**Autumn Coloration**	**Flowering Period**	**Form**
Leaf Characteristic	**.493****	0,160	-0,048	0,074	-0,040	0,074	-0,052	-0,228	**.426****	0,041	-0,005
Water Demand		**.289***	0,038	0,100	0,026	0,038	**-.247***	-0,180	0,181	-0,072	0,133
Soil Demand			-0,091	-0,082	0,044	0,193	**-.330****	**-.446****	0,125	0,050	0,124
Light Demand				-0,063	-0,066	-0,103	-0,212	-0,020	-0,016	-0,119	0,058
Food Source for Animals					**.536****	0,134	**.248***	0,142	0,038	**.326****	-0,101
Food Source for Humans						**.344****	**.284***	0,158	-0,017	0,149	0,112
Butterfly Attraction							**.481****	-0,198	-0,098	**.539****	-0,101
Bee Attraction								**.285***	-0,190	**.412****	**-.292***
Erosion Prevention									-0,067	-0,152	-0,042
Autumn Coloration										-0,041	0,022
Flowering Period											-0,218

If a p-value is less than 0.05, it is flagged with one star (*). If a p-value is less than 0.01, it is flagged with 2 stars (**).

Table 4 Relationship between criteria

4. Discussion and Conclusion

As stated in the material section, in choosing the research area, attention was paid to ensuring that the results were applicable to different fields beyond being local. The research area includes coastal areas at sea level as well as mountain areas above 2500 meters. This geographical difference also includes climatically different regions. In this way, the plant stock in the region will be identical to many different areas in the world in terms of its characteristics. At the same time, research parameters such as evaluated ecological and aesthetic criteria are factors that researchers in all parts of the world can benefit from.

In the coming years, it is a potential danger that the ecosystems existing in our urban areas will be affected, fragmented, and even destroyed, especially under the pressure of climate change. It is clear that the form and severity of the impact that this danger may cause will differ on the basis of countries and even cities (Shirgir et al., 2019; Gaglione and Ayiine-Etigo, 2021; Scheiber and Zucaro, 2023). As a matter of fact, Bastin et al. (2019), "Due to the possible effects of global warming in the coming years, more than 77% of the cities in the world may experience a change towards the climatic conditions of another major city by 2050. They also stated that 22% of them could switch to climatic conditions that are not currently available for any major city in the world" and that "the climate of Bursa city will be met with an average temperature increase of 2.4°C".

It is foreseen that this process, which can be experienced, will significantly and intensely affect urban areas and ecosystems. It is of great importance to ensure sustainability without breaking the existing chain of life in these areas. In this context, a good understanding of the natural landscape for sustainable ecosystems in urban areas, the adoption of native species (Flyger, 1974; Atkinson and Shackleton, 1991; Quinn, 1992; Gliwicz et al., 1994; Gustafson, 1998; Burger et al., 2004; Parker and Nilon, 2008; Parker and Nilon, 2012), for urban spaces where native species can easily adapt (Kowarik et al., 2013; Sjöman et al., 2016), the selection of suitable design plants by considering ecological concerns (Zencirkıran and Seyidoğlu Akdeniz, 2017) and the use of natural vegetation samples (Akdoğan 1972, Atik and Karagüzel, 2007) provide significant contributions.

On the other hand, native plants can adjust themselves to various sites, such as wet or dry, sun or shade, high or low fertility soils, and acidic or calcareous soils. If the usage is appropriate, native plants might: 1. be of an added contribution to wildlife, 2. require less maintenance, 3. provide a four-season use, 4. be a good option for irregular landscape planning, 5. preserve the native varieties, and maintain the biodiversity, and 6. add a local touch to the landscape (Sheaffer and Rose, 1998).

It is very rich in native plant taxa and has 1808 vascular plant taxa (Anonymous 2019). In this study, in which the ecological and aesthetic contributions of 72 woody taxa in Bursa flora to the ecosystem were examined, the relationships that emerged in terms of the criteria examined revealed essential results.

The existence of a positive relationship between features such as shelter for animals, being a food source, being a food source for humans, attracting butterflies, attracting bees, and preventing erosion, which are considered among ecological criteria in terms of contribution to the ecosystem, shows that the use of native plants is crucial for the preservation of ecosystem integrity.

Indeed, Shackleton (2016), McFrederick and LeBuhn (2006), and Frankie et al. (2005) emphasized in their studies that enriching the habitats in urban areas with native plants provides a source of food and shelter for more bird species and bees. Pardee and Philpott (2014), Pawelek et al. (2009), and Frankie et al. (2005) stated that the presence of native plants plays a vital role in the preservation of bee presence and diversity in urban ecosystems, while Karin et al. (2007) stated that there are more butterflies in native plants.

However, it has been emphasized that native plants provide critical benefits in preventing erosion and increasing pollination (Darricau, 2018; Elderbrock et al., 2020; Baqi et al., 2021) and contribute to the ecosystem by increasing biodiversity through their critical ecological functions (Kowarik, 2011).

Sustainability of ecosystem integrity, which is tried to be expressed above, is possible with designs made with natural taxa in the flora of that region (Zencirkıran, 2009; Korkut and ark., 2017), where natural resource consumption is minimized. In particular, the sustainability of the designs created with exotic plants, which do not contribute to the wildlife food web (Anonymous, 2019) due to some aesthetic concerns, does not seem possible due to the climate changes and urban pressures that may occur in the coming decades.

Although the study is specific to Bursa, both the characteristics of the region and the native plants found are common to many geographies of the world. For this reason, the points examined by the study are a guide for similar studies by the followers of the journal in their particular regions. Studies to be carried out in different regions will show us how native plants can be used in urban landscapes according to environmental priorities with a more extensive data set.

As a result, it is thought and recommended to pay attention to these issues that ecosystems in urban areas can be sustainable with design approaches in which the idea that they are the habitat of other living things within a system integrity and native plants and natural resources of that region are preferred. It is recommended to pay attention to these issues in designs in urban areas. All kinds of studies are gaining importance today in terms of protecting the environment, which has lost its balance due to the increase in natural destruction, climatic changes, and intensive construction. Demonstrating the relationship between the ecological needs of the plants that make up the natural cover of the regions with the protection and restoration of nature for scientific methodology will create a perspective that goes from local to global.

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Image Sources

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