What are the contributions of native plants to the urban ecosystem?

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Abstract

For 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, it is of great importance to ensure the sustainability of life chains in urban areas. In this context, a good understanding of the natural landscape and the adoption of local species make important contributions to urban areas for sustainable ecosystems. Natural plants interact with all physical and biotic factors in their areas and contribute to the life of natural living communities by easily adapting to environmental conditions. This research was carried out in Bursa (Turkey), which has a rich flora in terms of natural plant taxa. The contributions of 72 woody taxa in Bursa flora to the ecosystem were examined. The relationships that emerged in terms of the criteria examined revealed important results. The existence of a positive relationship between features, which are considered among ecological criteria in terms of contribution to the ecosystem, such as shelter for animals, being a food source, being a food source for humans, attracting butterflies, attracting bees, and preventing erosion, shows that the use of native plants is extremely important for the preservation of ecosystem integrity in urban areas.

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 garden, agriculture, parks, roadside design and rural restoration. One of the first practitioners of Miller's ideas was landscape architect Ossian C. Simonds working in the Chicago (SNR, 2011). Parallel to these developments, attempts to minimize human intervention and control in landscape design and applications have increased rapidly. The increase of 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, disseminating the use of more intense native plant species in urban areas (Deniz and Şirin, 2005).

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 great efforts. However, despite the challenges of existing in urban environments, many wildlife species have adapted to these systems. It is important to better understand the natural landscape 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; Perker 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, easily 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 extremely important 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 (Anoymous, 2019).

However, the existence of natural vegetation has unlimited direct and indirect benefits to the country's economy, and it is a resource in improving the climatic conditions of a country and preventing soil loss in other rural areas, laying the groundwork for scientific research, meeting the raw material and fuel needs of forest products, food, 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). 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.

Material And Methods

Material

The woody taxa (Table 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 utilised as study material.

Table 1
Native woody taxa evaluated as research material

1.*Pinus pinea* L.	**26.*Castanea sativa* Mill.**	**48.*Celtis australis* L.**
2.*Pinus brutia* Henry.	**27.***Quercus robur* L. ssp.robur	**49.***Tilia argentea* Desf.ex.DC.
3.*Pinus nigra* Arn. ssp. pallasiana (Lamb.) Holmboe.	**28.***Quercus frainetto* Ten. **29.***Quercus petraea*	**50.***Tamarix parviflora* DC. **51.***Cercis siliquastrum* L.
4.*Pinus silvestris* L. **5.***Abies nordmanniana* (Stev.)Spach ssp. bornmülleriana Mattf.	(Mattuschka) Liebl. ssp. iberica (Steven ex Bieb.) **30.***Quercus hartwissiana* Stev infectoria Olivier ssp.	**52.***Spartium junceum* L. **53.***Chamaecytisus hirsutus* (L.) Link. **54.***Chamaecytisus austriacus* (L.) Link. **55.***Chamaecytisus pygmaeus* (Willd)
6.*Juniperus communis* ssp. Nana **7.***Juniperus oxycedrus* L. **8.***Juniperus excelsa* L.	infectoria (Reut) Schwarz. **31.***Quercus pubescens* Wild. **32.***Quercus ithaburensis*	Rothm. **56.***Vitex agnus-castus* L. **57.***Hedera helix* L.
9.*Taxus baccata* L.	Decne ssp. Macrolepis	**58.***Daphne oleoides* Schreber
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.	Hedge.Yalt. **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.	**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.
20.*Arbutus andrachne* L. **21.***Erica arborea* L.	**42.***Salix caprea* L. **43.***Salix cinerea* L.	**70.***Ruscus aculeatus* L. **71.***Styrax officinalis* L.
22.*Vaccinium myrtillus* L.	**44.***Salix amplexicaulis* L.	**72.***Viburnum tinus* L
23.*Vaccinium uliginosum* L.	**45.***Populus alba* L	
24.*Vaccinium arctostaphyllos* L.	**46.***Populus tremula* L.	
25.*Fagus orientalis*	**47.***Ulmus glabra* L.	

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 (Figure 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. As you 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).

Methods

Using sources such as Davis (1965-1985), Dirr (1998), Hillier (1998), Zencirkıran (2004), Zencirkıran (2009), Zencirkıran (2013), Sarah et al. (2014), Florida-Friendly Landscaping™ Guide (2015), Zencirkıran et al (2019) Gardening with Native Plants, (2012), Native Plants for your Landscape (2012) Native and Adapted Landscape Plants (2009), Akkemik (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), food source for animals, 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 (IBM 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).

Results

Within the scope of the research, it was determined that 38.9% of the 72 woody taxa naturally found in Bursa flora and evaluated 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).

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.

Table 2
Distribution of taxa according to ecological and aesthetic criteria

		Ecological Criteria					Eesthetic 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.

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 analyzes 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.

Table 3
The mean values and standard deviations of the criteria

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

Table 4
Relationship between 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

A significant positive correlation was determined at the level of 1% between the leaf characteristics of taxa and their water demands. And also 1% significant positive correlation was determined between the leaf characteristics of the taxa and the autumn coloration, 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. 1% positive correlation was determined between attracting butterflies and attracting bees and also between butterfly attraction and flowering time. There is 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.

Discussion And Conclusions

For 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. 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 that can be experienced will affect especially urban areas and ecosystems intensely. 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; Perker 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 important 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 an irregular landscape planning, 5. preserve the native varieties and the 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 important 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 extremely important 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 an important 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) and contribute to the ecosystem by increasing biodiversity through their important 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 (Anoymous, 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.

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.

Declarations

Author's contributions All authors have equal contribution.

Data availability The data that support the findings of this study are

available from the corresponding author, upon reasonable request.

Compliance with ethical standards

Competing interests The authors have no conflicts of interest to declare that are relevant to the content of this article.

Ethics aprroval Not applicable.

Consent to participate Not applicable.

Consent for publication All the signing authors agree with the version sent and with its publication in Urban Ecosystems

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Figures

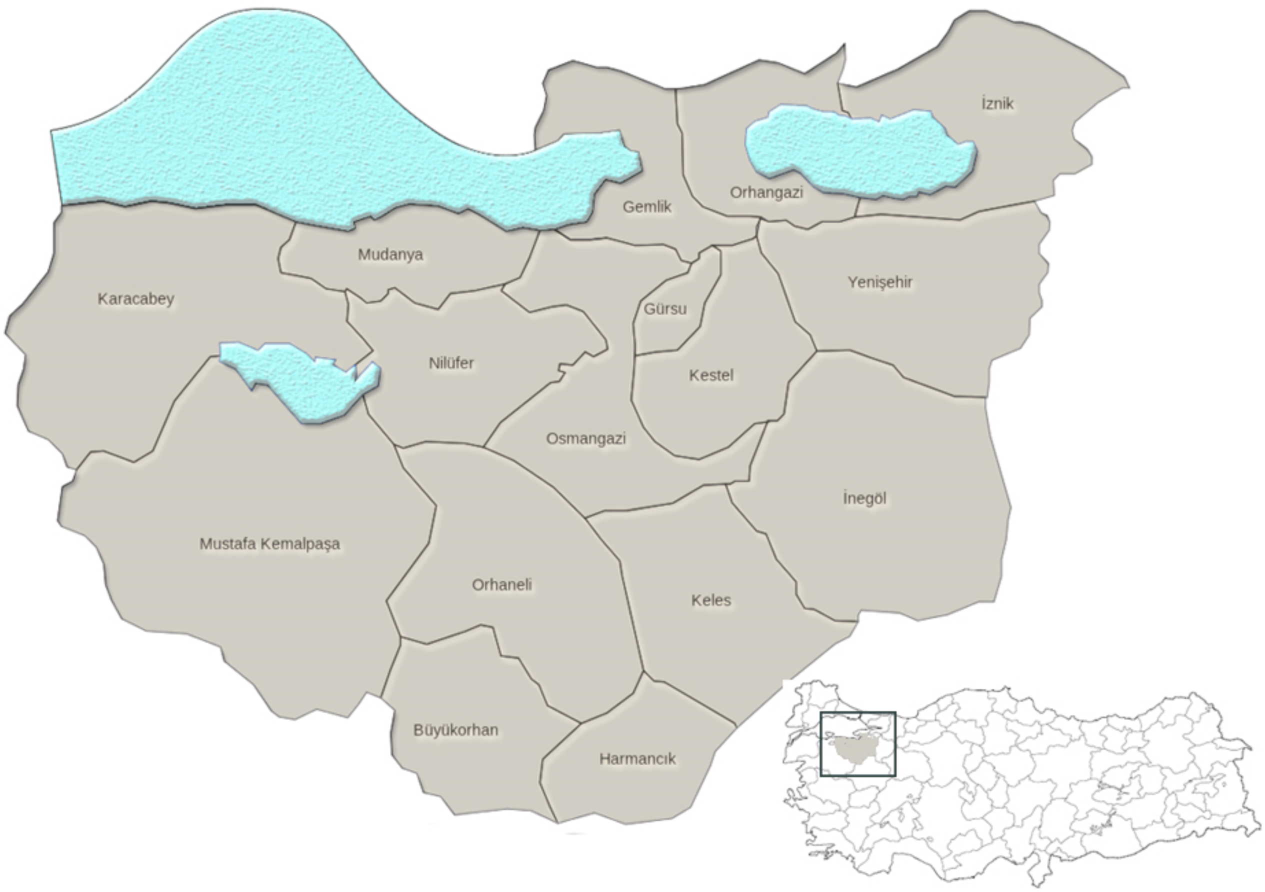

Figure 1

Location of the study area

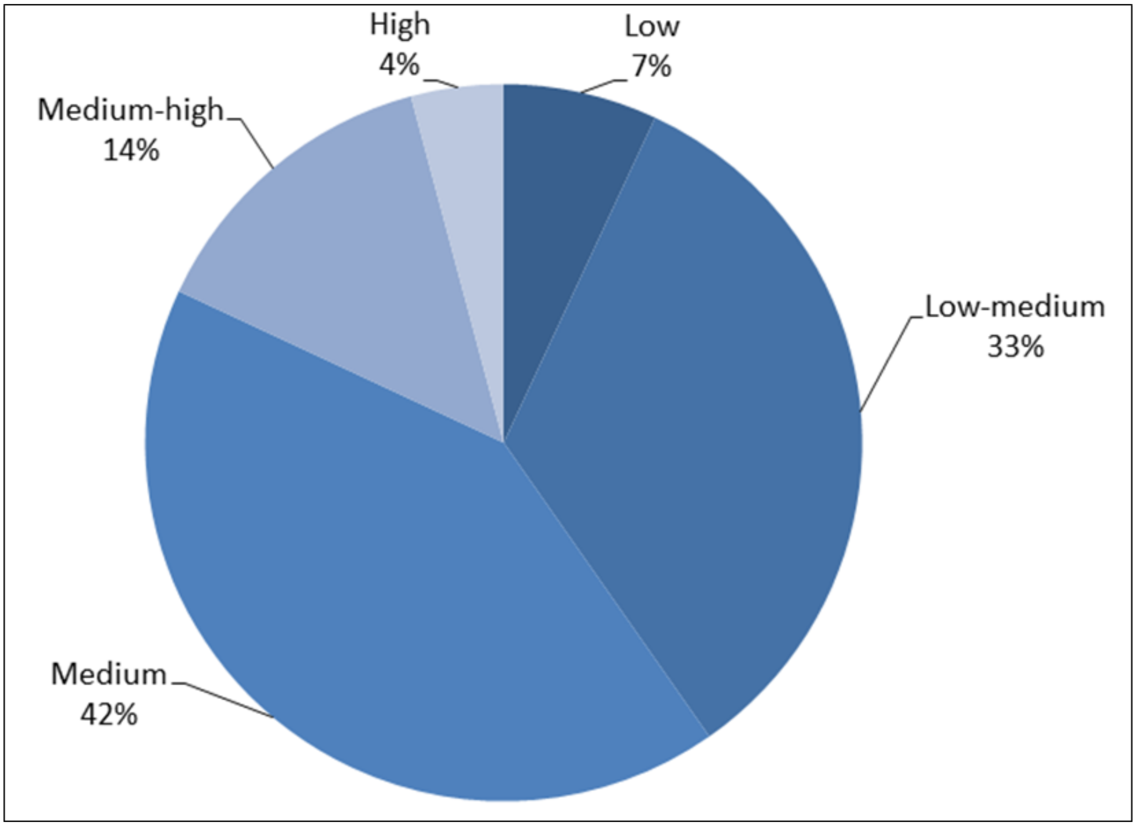

Figure 2

Distribution of the taxa according to their water demands

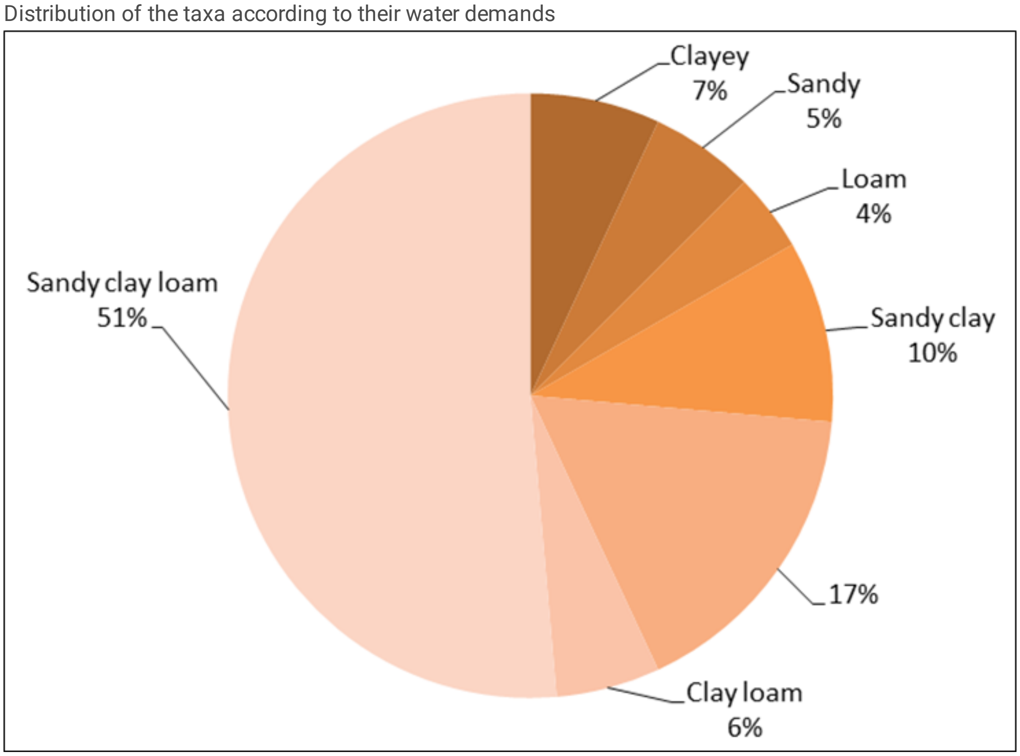

Figure 3

Distribution of the taxa according to their soil demands

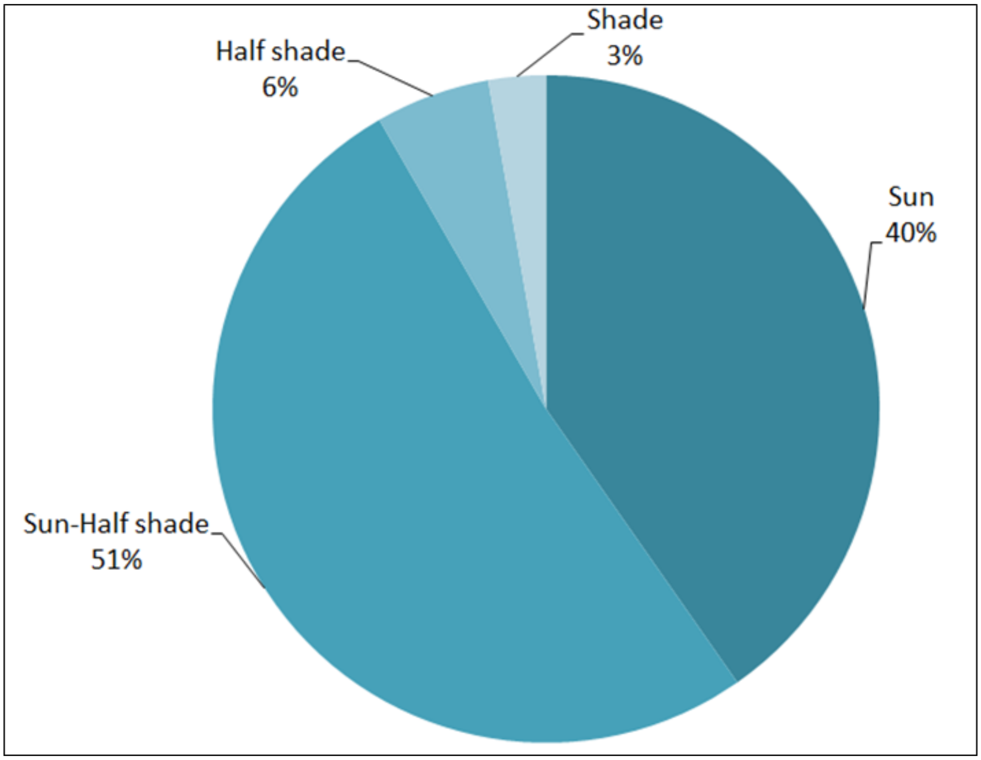

Figure 4

Distribution of the taxa according to their light demands

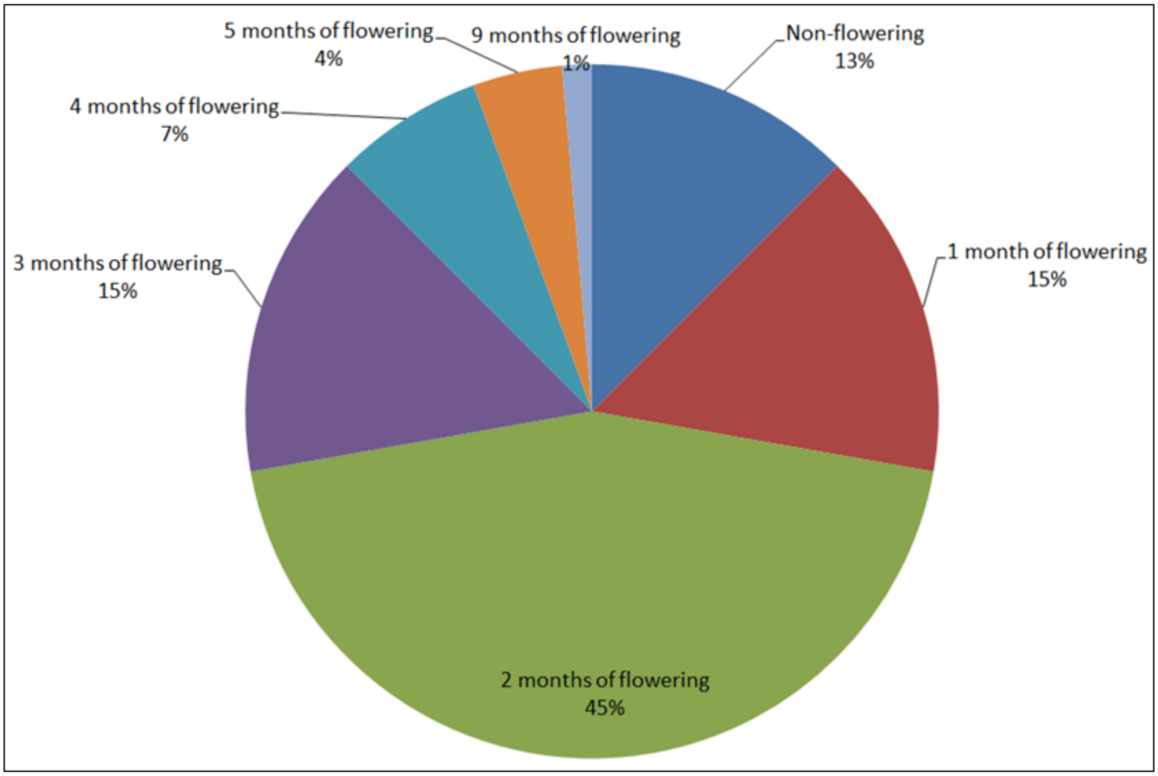

Figure 5

Distribution of the taxa according to their flowering times

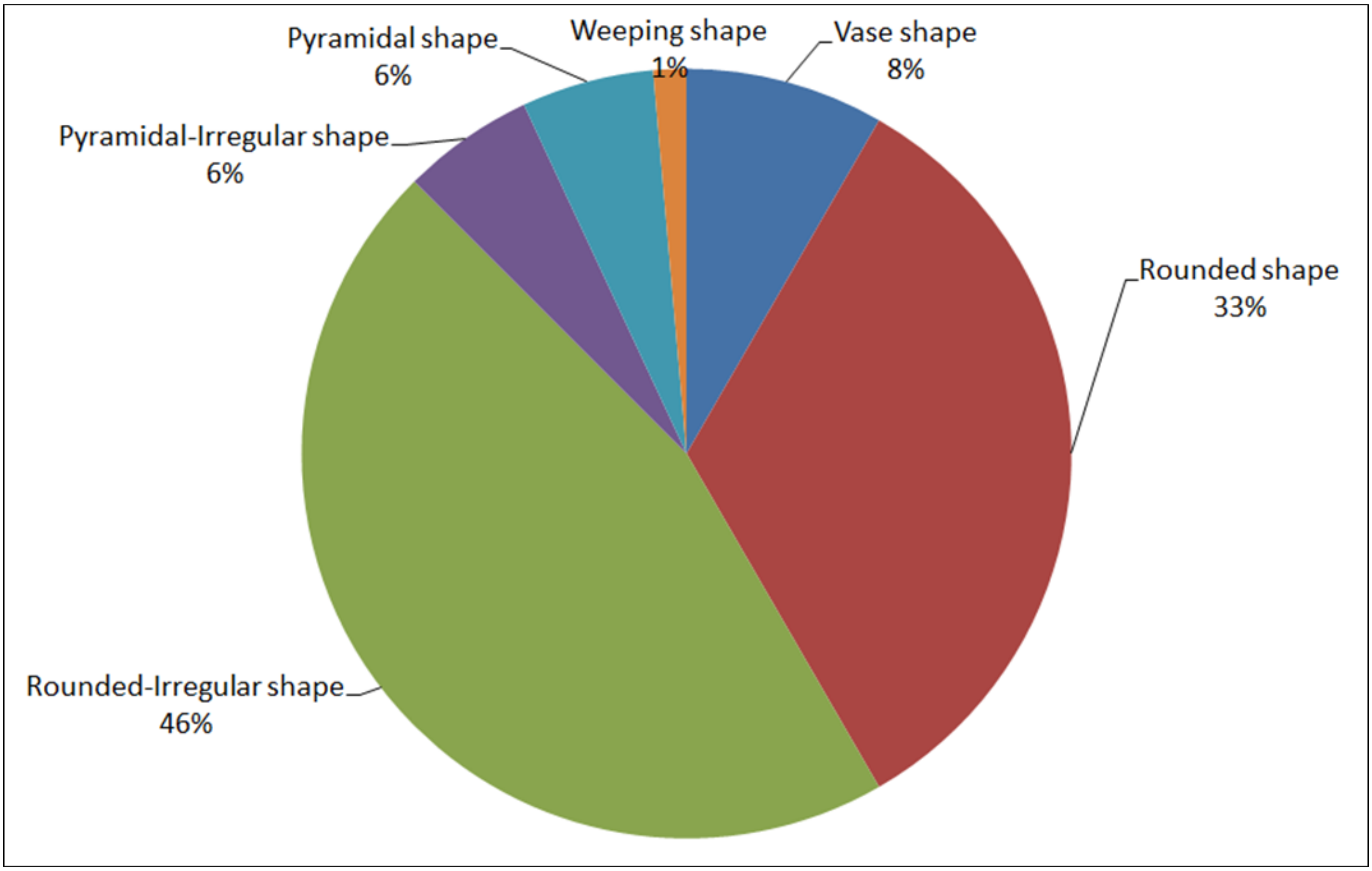

Figure 6

Distribution of the taxa according to their form characteristics