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Evaluation of the natural geophyte taxa of Sarıyer (Istanbul) and their use in urban landscape

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Abstract

Within approximately 5461 km^2 area and 16 million population, Istanbul is considered to be the most important and most crowded city of Turkey. In addition to its unique beauties, it attracts the attention of nature lovers and plant scientists especially with its rich variety of plants which is more than many other countries in the world. 7,2 % of this floristic richness is composed of "geophytes"; which are the plants with bulbous, tuberosus, corm or rhizomous root systems. Sarıyer district, which is located in the north side of Istanbul and being an important part of the city's floristic richness has been chosen as the study area. The floristic diversity of the district is mostly because of the biodiversity of natural forest called Belgrad Forest. In this study, investigating the geophytes of the Sarıyer district, one of the greenest districts of Istanbul, evaluating their aesthetic properties and examining the possibilities of their use in landscape designs is aimed. For this purpose, plant features and design characteristics, habitats and endangerment categories of Sarıyer geophytes have been studied in detail using various sources. As a result of this study; it is found that there has been 44 native genus and 98 exotic geophyte taxa belonging to 12 families. 27,27 % of the genera are belong to Orchidaceae family and it is followed by Amaryllidaceae family with 18,18 %. Also the geophytes in the study are mostly having tuberous root type with 38,78%. When the habitats of these taxa has been evaluated; forest, forest edge areas and shrubs has been found to be the highest rate of 19,85% and 19,73%. When we evaluate the geophyte taxa of Sarıyer in case of their use in landscape designs, their flower colors, flowering periods and textures has become important. In Sarıyer district mostly white and yellow flowering geophyte taxa has been found with 21,43% and 20,41% ratio. It is also seen that most of the geophyte taxa are flowering in March with 23,96% and most of them are 3 months flowering. Also most of them are found to be fine textured with 59,18%.

Keywords: Landscape design, Plant, Geophytes

Introduction

Today, ecological approaches in landscape design have been popular within the concept of sustainability. The necessity of landscape designs compatible with the natural habitats and native plants has arisen (Korkut et al. 2017, Zencirkiran et al. 2018). Plants and planting designs that are the basic elements of landscape design should be responsive with nature. Many features of plants such as line, form, texture and color should be evaluated and the best way of design should be done and the used plants should be

appropriate to the ecology of the area (Ayaşlıgil 2005) In this sense, the use of natural plants in the landscape design is of great importance.

Turkey is one of the most important countries of the world in terms of natural plant diversity. Its diversity is because of climate differences, topographic variations, geological and geomorphological variations, diversity of different aquatic environment such as marine, water, river etc., height differences ranging from 0-5000 m and differences in the location of three different phytogeographic areas (Ekim 2005). Within the flora researches in recent years it is revealed that Turkey's flora consists of about 12,500 plant taxa (Özhatay et al. 2003). Geophytes which are the plants that have rhizome, bulbous and tubular root system, is an important part of this rich flora. According to Davis (1965-1985) geophytes are represented by nearly 600 plant taxa in Turkey and about 40% them is endemic. This number is 800 according to Güner (2006) and 900 according to Kandemir and Yakupoğlu (2016).

In general, geophytes spend most of the year under the ground, the above-ground parts turn yellow after the growth is complete, and eventually dry out and die. However, the storage organs under the soil continue to survive (Anonymous 2019). Geophyt types include bulbs, corms, tubers, tuberous stems, tuberous roots, rhizomes and pseudobulbs (Kamenetsky and Hiroshi 2013). Although they are blooming in almost all seasons, they are generally classified as "spring geophytes" which are planted in autumn and bloom in spring and "fall geophytes" which are planted in spring and bloom in summer (Kılıçaslan and Dönmez 2016).

Geophytes has an economic value due to their remarkable flowers and their use in the pharmaceutical industry (Güner et al. 1991). They are the most preferred plants among ornamental plants due to their aesthetic properties, fragrances and usability as cut flowers (Çığ and Başdoğan 2015). The importance of geophytes has been begun to understand in recent years and especially *Tulipa* sp. and also *Muscari* sp., *Narcissus* sp. and *Hyacinthus* sp. have been participated in the landscape designs.

In order to create a composition, it is important to know the structural and visual characteristics of plants. The colors, line and texture properties of the plants should be evaluated and arranged in the best way and should be in accordance with the ecology and structural character of the area to be applied (Ayaşlıgil 2005; Düzenli et al. 2018). Color in design, affects human emotions by facilitating visual perception. Because of its contribution to design, a pleasing coordination of colors will be the goal.

One of the most important elements to be considered in the designs of geophytes is the "color". While two or more types of flower colors of geophyte taxa are preferred in large areas, it will be more effective to use one flower color in small areas. In large areas short heighted, small flowered and fine textured geophytes such as *Scilla* sp., *Crocus* sp. and *Colcihicum* sp. are preferred to create continuity in design. In general with almost every period of the year geophytes are flowering but mainly they are flowering in spring and autumn. Flowering periods of them are chancing according to the species. With a wisely design the beautiful appearance of their flowering can be spread in a year. (Seyidoglu et al. 2009). As a matter of fact, the importance of colors is undeniable in designs to be made with geophytes as in other landscape plants. As such, the use of bright yellow-flowered *Strenbergia* sp. and light purple-flowered *Colchicum* sp. in groups adds charm and feelings of joy and self-confidence. With the use of *Hyacinthus* sp. with its fragrant purple-colored flowers together with light yellow flowering *Narcissus* sp. evoke joy, purity and innocence, as well as the creation of beautiful looks. In the silent and shady places, the selection of white-flowered species ensures both color harmony and continuity (Seyidoglu et al. 2009; Zencirkıran et al.

2018). Very beautiful looks can be obtained with spherical and spiral shaped flowers with *Allium* sp., *Cammasia* sp. and *Galtonia* sp.

Along with color, many factors such as form, texture, flowering time and flowering periods should not be overlooked in designs. The flowering times of the geophytes vary according to the species and in the design to be made, by applying in a way that the flowering times will span one year, and so beautiful views will be obtained throughout the year.

However, the most effective and natural looks can be created with informal drifts or group plantings in the use of geophytes. While using geophytes as drifts, it is an important approach to design using topography in the form of gently climbing a hillside or surrounding a high point. Another approach is to create a naturalizing effect by sprinkling geophytes on the area. For this purpose, short-sized, small-flowered or fine textured species such as *Scilla* sp., *Crocus* sp., *Colchicum* sp. should be preferred. On the other hand, using geophytes in groups in combination with other plant species, gives the garden continuity and charm. Tall geophytes such as *Lilium* sp., *Fritilllaria* sp., *Tulipa* sp. can be used together; and also the shorter ones such as *Muscari* sp., *Galanthus* and *Crocus* sp. can be used together. It is possible to create a pleasant effect with the use of *Colchicum* sp. in combination with thin-shaped shrubs and using species such as *Anemone blanda* and *Scilla nutans* under trees (Anonymous 2018, Seyidoğlu et al. 2009).

In order to bring different species to the urban landscape, it is important to identify the current status of the geophytes in flora, and to introduce the species to be cultured by evaluating their design features and habitats. From this point, this study deals with the Sarıyer district which is a part of Belgrad Forest and also has different habitats and has appropriate geography for the geophyte taxa. For revealing the current status of natural habitats and plant and design characteristics of geophytes for urban landscape designs has been examined and suggestions have been developed.

Material and Methods

Study area

Sarıyer district has been chosen as the study area because of its geographic location, hosting different habitat types and its high diversity of geophyte taxa. The main material of the study is composed of the natural geophyte taxa of Sarıyer district.

Sarıyer district is located on the European side of Istanbul at the intersection of approximately 41^0 N latitude and 29^0 E longitude. Sarıyer is bordered by Bosphorus in the east, Black Sea in the north, Eyüp in the west, Şişli and Beşiktaş in the south. On the one hand the border with the Bosphorus, on the other hand the fact that the border to the Black Sea increases the level of development. The settlement lies along the coast in Sarıyer. Its surface area is 152,26 km^2 and its altitude is 74m. (Figure 1).

Sarıyer has a temperate and humid climate type. The Walter climate diagram of Sarıyer district according to 1950-2015 climate data has been given on Figure 2 and Table 1. Therefore, Sarıyer is one of the richest districts of Istanbul in terms of plant diversity. The eastern end of the Belgrade Forest is introduced into the district. Furthermore, the area within the Rumelikavağı-Rumelifeneri-Kilyos triangle is largely covered with forests. Sarıyer has the characteristics of Black Sea climate in general. It is mild and humid climate type (Anonymous 2015-2019).

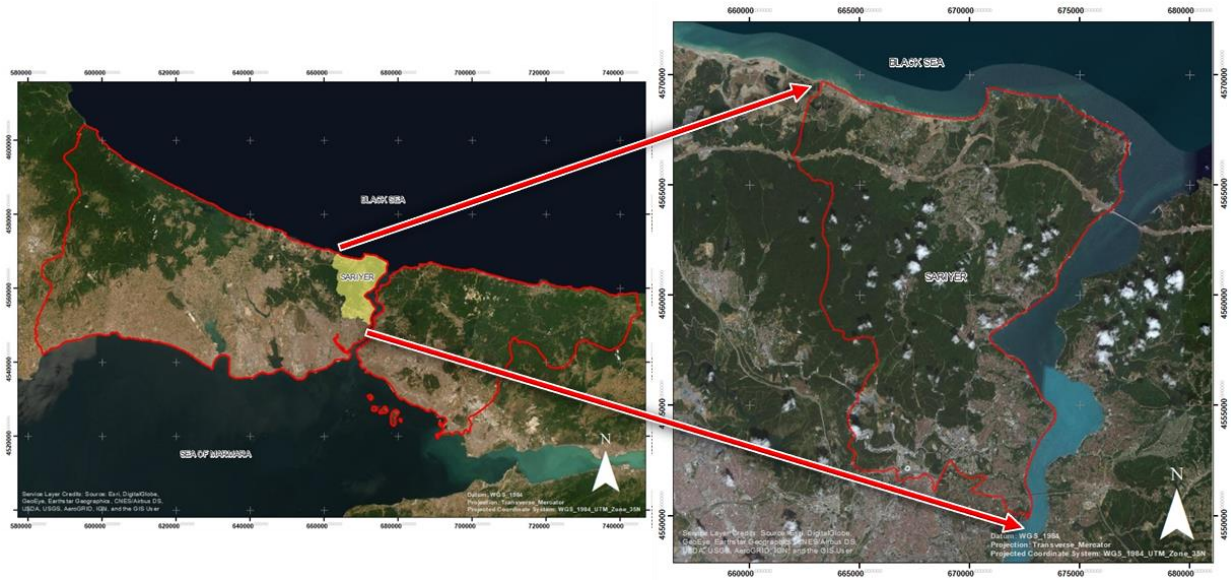

Figure 1. The location of research area in Istanbul

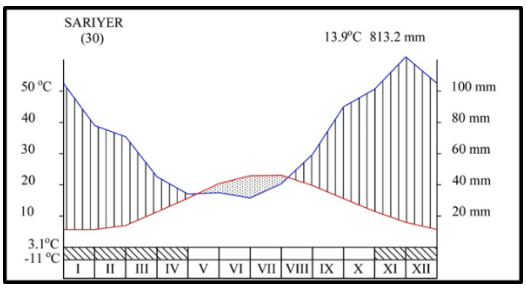

Figure 2 - Climate diagram of Sarıyer (Walter, 1960)

Table 1: The average mean temperature and precipitation data of Sarıyer

Month	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
MAT.	5,7	5,7	7	11,1	15,7	20,4	22,9	23,1	19,8	15,6	11,5	8
MAR.	105	78	70,8	45,2	34,1	35	31,6	40,7	59,5	90	101,3	122

MAT=Mean Annual Temperature, MAR=Mean Annual Rainfall

The district is generally composed of hills and valleys. Due to the terrain, transportation is limited. It is surrounded by seas on both sides and has a coast length of 47 km. On the coast, after a narrow coastline, very steep slopes rise. Among the major elevations seen within the borders of Sarıyer are; Büyüktepe, Tarabya, Maltıztepe, Kocataş Hill, İbrahim Paşa Hill, Şeytandağı, Tabya Hill, Kartaltepe and Ağlamışbaba Hill (Anonymous 2015-2019).

There are many small and large rivers within the borders of the district. Sarıyer has shores to the Black Sea and the Bosphorus. The beaches facing the Black Sea are steep slopes and forested. Black Sea Coast is quite indented protruding on the east of Kumköy but the west part is flat. (Anonymous 2015-2019)

Methods

Data collection, observation and evaluation methods have been used in this study. In the data collection stage, the natural geophytes of Sarıyer, has been evaluated from different references (Bayraktar 2013, Çolak et al. 2013, Davis 1965-1985, Davis et al. 1988, Güner et al. 2000, RHS 2019, Tubives 2004, Yaltırık 1963, Yönelli 1986).

The situated geophyte taxa were evaluated in 2 categories such as 'plant features' and 'design features'. In the concept of plant features; the underground organ structures has been categorized as bulbous, rhizom, tuber and corm. And also the geophyte taxa were evaluated as genus, species or subspecies according to their families. On the other hand, geophyte taxa have been classified according to the endangerment categories by making benefit of 'The Red Data Book of Turkey's Plants' and 'IUCN Red List Categories' (Ekim et al. 2000, IUCN 2019). According to these criteria the geophyte taxa of Sarıyer categorised as CR (Critically endangered), EN (Endangered), VU (Vulnerable), LR (cd) (Conservation dependent), LR (nt) (Near threatened), LR (lc) (Least concern) and DD (Data deficient).

Within the concept of design features; flower structures and texture structures has been evaluated. According to their flower structures they were evaluated in 3 categories such as flower colors, flowering start time and flowering periods which are the most important elements of planting design. (Davis 1965-1985, Davis et al. 1988, Seyidoglu et al. 2009, Tubives 2014, Kılıçarslan and Dönmez 2016, Zencirkıran et al. 2018). The texture properties of the geophyte taxa were evaluated in 2 categories such as texture features and heights. Texture features of geophyte taxa were categorized as fine, medium and coarse texture. For evaluating the data Frequencies analyze at the SPSS 23 package progmamme has been used.

Results

Plant Features

In Sarıyer district, there has been native 44 genus and 98 geophyte taxa belonging to 12 families. In Table 2; geophyte taxa belonging to these 12 families is given.

Table 2. The geophyte taxa of Sarıyer

Family name	Genus name	Taxa name
Amaryllidaceae	*Allium* L.	*Allium ampeloprasum* L., *Allium cepa* L., *Allium neapolitanum* Cyr., *Allium pallens* subsp. *pallens* L., *Allium paniculatum* subsp. *paniculatum*, *Allium roseum* L., *Allium rubellum* Bieb., *Allium scorodoprasum* subsp. *rotundum* (L.) Stearn, *Allium scorodoprasum* subsp. *scorodoprasum* L., *Allium triquetrum* L.
	Gagea Salisb.	*Gagea chrysantha* (Jan) Schultes et Schultes Fil.
	Galanthus L.	*Galanthus gracilis* Celak, *Galanthus nivalis* L., *Galanthus plicatus* subsp. *byzantinus* (Baker) D. A. Webb, *Galanthus plicatus* subsp.*plicatus* Baker., *Galanthus valentinei* nothosubsp. *subplicatus*
	Leucojum L.	*Leucojum aestivum* L.
	Narcissus L.	*Narcissus assoanus* Dufour, *Narcissus jonquilla* L., *Narcissus poeticus* subsp. *poeticus*, *Narcissus pseudonarcissus* L., *Narcissus tazetta* subsp. *aureus* (Loisel.) Baker

	Nectaroscordum Lindl.	*Nectaroscordum siculum* (Ucria) Lindl.subsp. *bulgaricum*
	Pancratium L.	*Pancratium maritimum* L.
	Sternbergia Waldst.et Kit.	*Sternbergia colchiciflora* Waldst. et Kit.
Asparagaceae	*Asparagus* L.	*Asparagus acutifolius* L., *Asparagus aphyllus* subsp.*orientalis* Baker.
	Bellevalia Lapeyr.	*Bellevalia trifoliata* (Ten.) Kunth
	Muscari Miller	*Muscari comosum* (L.) Miller, *Muscari neglectum* Guss., *Muscari parviflorum* Desf.
	Ornithogalum L.	*Ornithogalum narbonense* L., *Ornithogalum sigmoideum* Freyn et Sint., *Ornithogalum sphaerocarpum* Kerner, *Ornithogalum wiedemannii* var. *wiedemannii* Boiss., *Ornithogalum montanum* Cyr., O*rnithogalum orthophyllum* Ten., *Ornithogalum arabicum* L.
	Ruscus L.	*Ruscus aculeatus* var. *aculeatus* L., *Ruscus hypoglossum* L.
	Scilla L.	*Scilla autumnalis* L., *Scilla bifolia* L.
Araceae	*Arum* L.	*Arum byzantinum* Blume
Colchicaceae	*Colchicum* L.	*Colchicum micranthum* Boiss., *Colchicum turcicum* Janka
Geraniaceae	*Erodium* L'Herit.	*Erodium cicutarium* (L.) L'herit., subsp. *cicutarium*
	Geranium L.	*Geranium asphodeloides* subsp. *asphodeloides* Burm. f., *Geranium dissectum* L., *Geranium lucidum* L., *Geranium purpureum* Vill., *Geranium robertianum* L.
Iridaceae	*Crocus* L.	*Crocus biflorus* Miller, *Crocus flavus* Weston, *Crocus olivieri* subsp. *olivieri* Gay, *Crocus olivieri* subsp. *istanbulensis* Mathew, *Crocus pestalozzae* Boiss., *Crocus pulchellus* Herbert
	Iris L.	*Iris pseudacorus* L., *Iris sintenisii* Janka
	Romulea Maratti	*Romulea columnae* subsp. *columnae* Seb.et Mauri, *Romulea linaresii* subsp. *graeca* Beg.
Liliaceae	*Erythronium* L.	*Erythronium dens-canis* L.
	Fritillaria L.	*Fritillaria pontica* Wahlenb.
	Lilium L.	*Lilium martagon* L.
	Anacamptis L.C.M. Richard	*Anacamptis laxiflora* subsp. *laxiflora* (Lam.)R.M.Bateman, Pridgeon & M.W.Chase
	Cephalanthera L.C.M. Richard	*Cephalanthera longifolia* (L.) Fritsch
	Dactylorhiza Necker ex Nevski	*Dactylorhiza romana* subsp.*romana* (Seb.)Soo.
	Epipactis Zinn	*Epipactis helleborine* (L.) Crantz, *Epipactis palustris* (L.) Crantz
	Himantoglossum W.D.Koch	*Himantoglossum carpinum* (Bieb)Sprengel.
	Neotinea Reichb.Fil.	*Neotinea maculata* (Desf.)Stearn.

Orchidaceae	*Neottia* Guettard	*Neottia nidus-avis* (L.) L.C.M. Richard
	Ophrys L.	*Ophrys apifera* Hudson
	Orchis L.	*Orchis papilionacea* L., *Orchis papilionacea* var.*rubra* Jacq., *Orchis laxiflora* Lam.
	Platanthera L.C.M. Richard	*Platanthera bifolia* (L.) L.C.M. Richard, *Platanthera chlorantha* (Custer) Reichb.
	Serapias L.	*Serapias bergonii* E.G.Camus, *Serapias cordigera* L., *Serapias vomeraca* (Burm) Briq. subsp. *laxiflora* Gölz ex Rein.
	Spiranthes L.C.M.Richard	*Spiranthes spiralis* (L.)Chevall.
Primulaceae	*Cyclamen* L.	*Cyclamen coum* Miller var. *coum*
	Lysimachia L.	*Lysimachia nummularia* L., *Lysimachia verticillaris* Sprengel
	Primula L.	*Primula vulgaris* subsp. *sibthorpii* (Hoff.)W.W.Sm. & Forrest
Ranunculaceae	*Anemone* L.	*Anemone nemorosa* L.
	Helleborus L.	*Helleborus orientalis* Lam.
	Ranunculus L.	*Ranunculus constantinopolitanus* (DC.) D'urv., *Ranunculus ficaria* subsp. *calthifolius* (Reichb.) Arc., *Ranunculus ficaria* subsp. *ficariiformis* Rouy et Fouc., *Ranunculus gracilis* Clarke, *Ranunculus marginatus* var. *marginatus* D'urv., *Ranunculus ophioglossifolius* Vill., *Ranunculus repens* L., *Ranunculus saniculifolius* Viv.
Rosaceae	*Geum* L.	*Geum urbanum* L.
Xanthorrhoeaceae	*Asphodelus* L.	*Asphodelus aestivus* Brot.

Geophyte taxa of Sarıyer has been classified according to the endangerment categories in Table 3 (Ekim et al. 2000, IUCN 2019).

Table 3. Classification of geophyte taxa according to the category of endangerment

Danger catagories	Taxa	F (%)
DD Data defficient	*Galanthus gracilis* Celak., *Narcissus jonquilla* L.	12,50
LR (Lc) Least concern	*Allium ampeloprasum* L., *Allium triquetrum* L., *Galanthus plicatus* subsp. *byzantinus* (Baker) D. A. Webb, *Galanthus plicatus* subsp. *plicatus* Baker., *Leucojum aestivum* L., *Asparagus acutifolius* L., *Asparagus aphyllus* subsp.*orientalis* Baker., *Muscari parviflorum* Desf., *Iris pseudacorus* L., *Epipactis palustris* (L.) Crantz, *Neottia nidus-avis* (L.) L.C.M. Richard, *Lysimachia nummularia* L., *Ranunculus ophioglossifolius* Vill., *Ranunculus saniculifolius* Viv.	87,50

F (%): Frequencies of the taxa.

Design Features

Evaluations of flower colours, which is one of the important criteria for landscape design, is given in Table 4.

Table 4. Flower colours of geophyte taxa

Flower Clour	Plant taxa
White	*Allium cepa* L., *Allium neapolitanum* Cirillo., *Allium triquetrum* L., *Galanthus gracilis* Celak, *Galanthus nivalis* L., *Galanthus plicatus* subsp. *byzantinus* (Baker) D. A. Webb, *Galanthus plicatus* subsp. *plicatus* Baker., *Galanthus valentinei* nothosubsp. *subplicatus*, *Narcissus poeticus* subsp. *poeticus*, *Ornithogalum narbonense* L., *Ornithogalum sigmoideum* Freyn & Sint., *Ornithogalum wiedemannii* var. *wiedemannii* Boiss., *Ornithogalum montanum* Cyr., O*rnithogalum orthophyllum* Ten., *Ornithogalum arabicum* L., *Crocus pestalozzae* Boiss., *Cephalanthera longifolia* (L.) Fritsch, *Epipactis palustris* (L.) Crantz, *Platanthera bifolia* (L.) L.C.M. Richard, *Pancratium maritimum* L., *Leucojum aestivum* L.
Yellow	*Narcissus assoanus* Dufour, *Narcissus jonquilla* L., *Narcissus pseudonarcissus* L., *Narcissus tazetta* subsp. *aureus* (Loisel.) Baker, *Asparagus acutifolius* L., *Iris pseudacorus* L., *Lysimachia nummularia* L., *Lysimachia verticillaris* Sprengel, *Primula vulgaris* subsp. *sibthorpii* (Hoff.)W.W.SM. et For., *Ranunculus constantinopolitanus* (DC.) D'urv., *Ranunculus ficaria* subsp. *calthifolius* (Reichb.) Arc., *Ranunculus ficaria* subsp. *ficariiformis* Rouy et Fouc., *Ranunculus gracilis* Clarke, *Ranunculus marginatus* var. *marginatus* D'urv., *Ranunculus ophioglossifolius* Vill., *Ranunculus repens* L., *Ranunculus saniculifolius* Viv., *Geum urbanum* L., *Gagea chrysantha* (Jan) Schultes et Schultes Fil., *Sternbergia colchiciflora* Waldst. et Kit.
Purple	*Allium ampeloprasum* L., *Allium scorodoprasum* L. subsp. *rotundum* (L.) Stearn, *Allium scorodoprasum* L. subsp. *scorodoprasum* L., *Muscari parviflorum* Desf., *Scilla autumnalis* L., *Geranium dissectum* L., *Geranium purpureum* Vill., *Iris sintenisii* Janka, *Anacamptis laxiflora* subsp. *laxiflora*, *Cyclamen coum* Miller var. *coum*, *Orchis laxiflora* Lam., *Himantoglossum carpinum* (Bieb)Sprengel., *Romulea linaresii* Parl. subsp. *graeca* Beg., *Colchicum turcicum* Janka, *Bellevalia trifoliata* (Ten.) Kunth
Pink	*Allium paniculatum* subsp. *paniculatum*, *Allium roseum* L., *Allium rubellum* Bieb., *Erodium cicutarium* subsp. *cicutarium* (L.) L'herit., *Geranium lucidum* L., *Lilium martagon* L., *Helleborus orientalis* Lam., *Orchis papilionacea* L., *Orchis papilionacea* var. *rubra* Jacq., *Neotinea maculata* (Desf.) Stearn., *Erythronium dens-canis* L.
Lilac	*Muscari comosum* (L.) Miller, *Geranium asphodeloides* subsp. *asphodeloides* Burm. fil., *Geranium robertianum* L., *Crocus biflorus* Miller, *Crocus pulchellus* Herbert, *Anemone nemorosa* L., *Colchicum micranthum* Boiss.
Purplish Brown	*Arum byzantinum* Blume, *Serapias bergonii* E.G.Camus, *Serapias cordigera* L., *Serapias vomeraca* subsp. *laxiflora* Gölz ex Rein., *Romulea columnae* subsp. *columnae* Seb.et Mauri
Greenish White	*Ruscus aculeatus* var. *aculeatus* L., *Ruscus hypoglossum* L., *Platanthera chlorantha* (Custer) Reichb., *Spiranthes spiralis* (L.) Chevall.
Cream	*Allium pallens* subsp. *pallens* L., *Ornithogalum sphaerocarpum* Kerner, *Dactylorhiza romana* subsp.*romana* (Seb.)Soo.
Orangish Yellow	*Crocus flavus* Weston, *Crocus olivieri* subsp. *olivieri* Gay, *Crocus olivieri* subsp. *istanbulensis* Mathew
Pinkish White	*Ophrys apifera* Hudson, *Asphodelus aestivus* Brot., *Nectaroscordum siculum* subsp. *bulgaricum* (Ucria) Lindl.
Blue	*Muscari neglectum* Guss. ex Ten., *Scilla bifolia* L.
Green	*Asparagus aphyllus* subsp.*orientalis* Baker., *Fritillaria pontica* Wahlenb.
Yellowish Brown	*Neottia nidus-avis* (L.) Rich.
Multicolored	*Epipactis helleborine* (L.) Crantz

Discussion

It was observed that most of the geophyte genera are belong to Orchidaceae family with 27,27 %. The family Orchidaceae is followed by Amaryllidaceae (18,18 %) and Asparagaceae (13,64 %) families. Araceae, Colchicaceae, Rosaceae and Xanthorrhoeacea families represented with a single genera. When the families were evaluated according to the number of taxa, it was observed that Amaryllidaceae was the biggest family with 25,51 % ratio. The family Amaryllidaceae is followed by Orchidaceae (18,87 %) and Asparagaceae (17,35 %) families. However Rosaceae and Xanthorrhoeacea families represented with a single taxon (Figure 3).

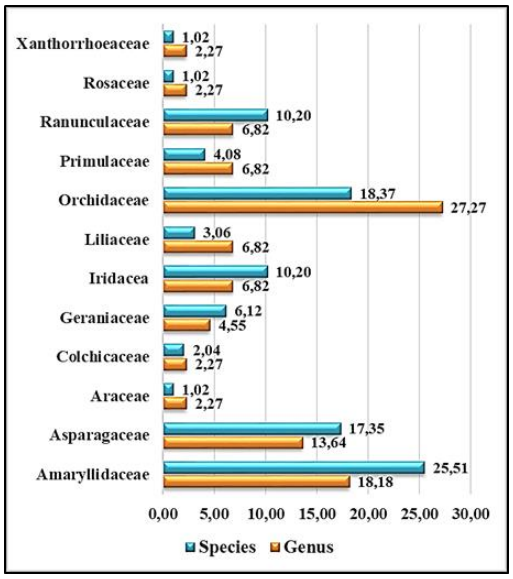

Figure 3. The distribution of genus, species and subspecies of geophytes according to families

When the geophytes of Sarıyer district classified according to their underground types, it is seen that mostly tuberous taxa has been found with the rate of 38,78%, bulbous of 31,63%, rhizome of 19 % and the least corm of 10,20% (Figure 4).

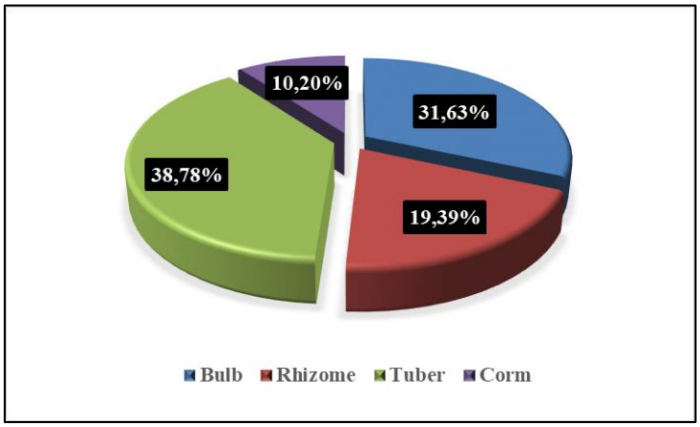

Figure 4. The distribution of geophytes according to underground types

However when the habitats of these taxa has been evaluated, forest, forest edge areas and shrubs has been found to be the highest rate of 19,85% and 19,73%. At the same time the minimum ratio of habitats found to be cultivated areas with 1,12%, road sides 1,87% and degraded habitats with 1,50% (Figure 5).

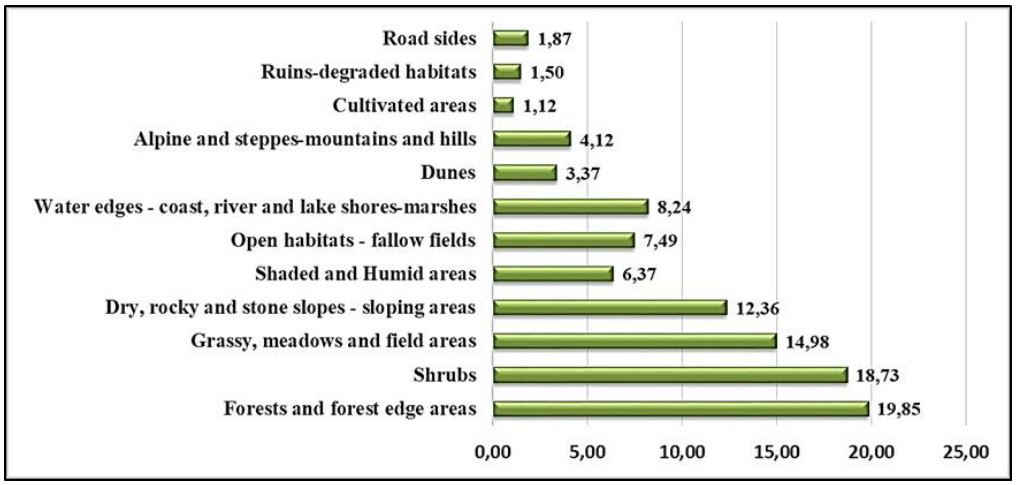

Figure 5. Classification of geophyte taxa according to habitats

On the other hand when they has been evaluated in case of the category of endangerment; it has been found out that most of the taxa are in LR (lc) (Least concern) category with the rate of 87,50 %. The rest of the taxa are in the DD (Data deficient) category with 12,50 %. In the scope of CR (Critically endangered), EN (Endangered), VU (Vulnerable), LR (cd) (Conservation dependent) and LR (nt) (Near threatened) categories no taxa has been found (Table 3).

Within the results of the assessments made by the flower colours of geophytes located in Sarıyer, the highest rate has been white flowered geophyte taxa with 21,43% ratio. 20,41% of them has been found to be yellow flowering species and %15,31 has been purple flowering species. The lowest rate with 1,02% has been yellowish brown and multicolored flowering species (Figure 6).

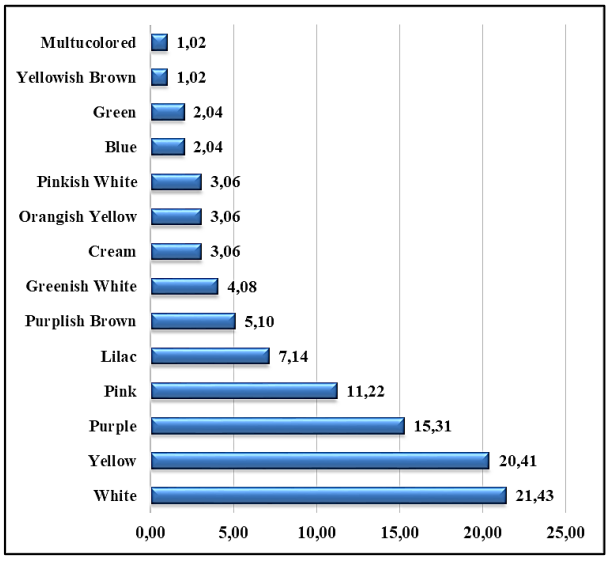

Figure 6. The distribution of geophyte taxa according to flower colours

Flowering start time and flowering periods of the geophytes is a very important issue in planting design as well as their flower colours. Within the results of the assessments made by the flowering times of geophytes located in Sarıyer, it has seen that 35,42% of the Sariyer district geophytes are flowering in March and 23,96% of them are flowering in April. 10,42% of them are flowering in June. Autumn and

winter flowering geophytes are the least and also it has seen that in October and December no geophyte taxa is flowering in Sarıyer (Figure 7).

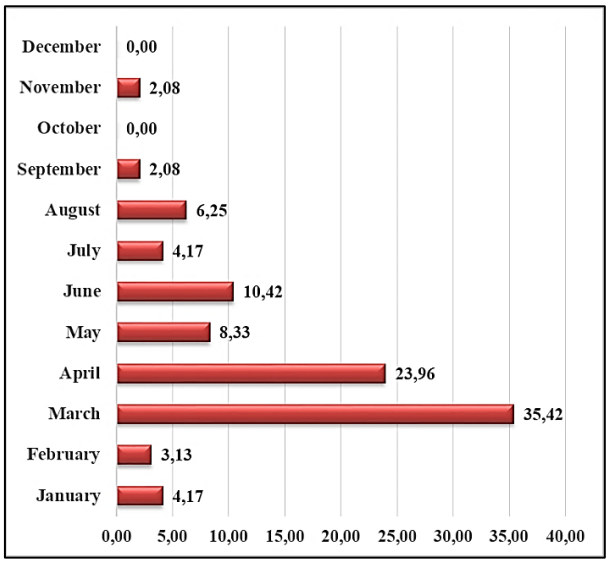

Figure 7. The distribution of geophyte taxa according to flowering start times

However, when the flowering period of the taxa has been examined, it is determined that 41,84% of the detected taxa are 3 months flowering. 26,53% of them are 2 months and 16,63% are 4 months flowering in the flora of Sarıyer. 6 months flowering are with the rate of 3,6% 5 months flowering with the rate of 2,04% and 7 months flowering 1,02%. Also it has been found out that 8 months and more flowering geophytes are absent in the area (Figure 8).

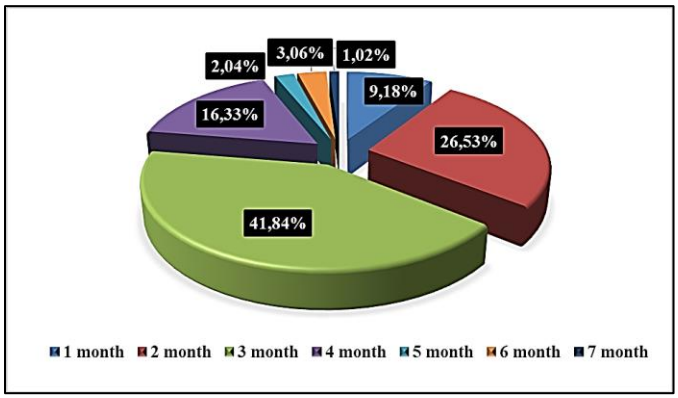

Figure 8. The distribution of geophyte taxa according to flowering periods

When the Sarıyer geophyte taxa has been evaluated in case of their texture structures, it is seen that 59,18 % of them are fine textured and 40,82 % of them are coarse textured. On the other hand it has been examined that 46,41 % of them are short; 22,88 % of them are above 21-40 meters and 3,92 % of them are 100 meters and above (Figure 9).

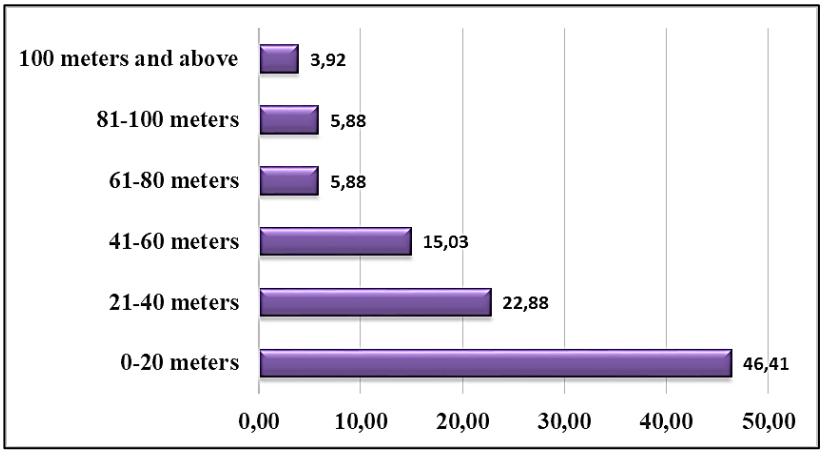

Figure 9. The distribution of geophyte taxa according to plant heights

Istanbul is one of the biggest cities of Turkey; with its floristic diversity. It has approximately 2,500 native plant taxa which is more than many countries around the world. The Sarıyer district which is the study area, constitutes the important source of this diversity by hosting the most important natural forest of the city, called Belgrade Forest which constitutes an important source of wealth (Çoban et al., 2016). The diversity of taxa in the area that grows naturally and requiring minimum maintenance, shows that a sustainable landscape practices available at this area. Therefore Sarıyer district has a different significance for the ecology of Istanbul.

Within this study the native geophyte taxa of Sarıyer and their usage in urban landscape areas has been evaluated and it is found that with 98 natural geophyte taxa, the area shows quite rich diversity in terms of geophytes. The major underground organ structure of them has been found to be bulb (38,78%). According to the number of species in the families, Orchidaceae is the first one, however Rosaceae and Butomace families has been represented by a single species. In terms of endangerment categories the geophyte taxa are usually at LR (lc) (Least concern) category with 87,50% and at DD (Data deficient) category with 12,50%. When they has been categorized according to their habitats; it is seen that they are under the category of mostly forests, forest edge areas and shrubs.

Similarly, Akdeniz and Zencirkıran (2016) found that the geophyte taxa of Bursa province has a rich diversity and their underground structure was mostly bulbous. And also they said that according to the endangerment categories they were mostly at LR (lc) (Least concern) category. However in the study of Avcu et al. (2016) which was about the geophyte taxa of Katran Mountain, the underground organ structures were found to be mostly bulb (40,75%). Sargın et al. (2013) found that at the Alaşehir (Manisa) region, 60 geophyte taxa were native and they were mostly belong to Amaryllidaceae, Araceae, Asparagaceae, Iridaceae, Liliaceae, Orchidaceae, Primulaceae and Ranunculaceae families. On the other hand, Dechir et al. (2019) stated that North-East Algeria is rich in bulbous and corm geophytes with 67 species and 19 endemic species, but also stated that they should be taken under protection.

As a matter of fact, Bradshaw and Handley (1982) stated that natural vegetation requires little intervention and can decrease the cost; Korkut et al. (2017) suggested the use of native plants that do not require much maintenance and suitable for natural structure in the landscape design studies within the framework of ecological approaches. Cabi (2016) stated that the highest genera in Tekirdağ city are *Allium* sp., *Ornithogalum* sp., *Orchis* sp., *Crocus* sp. and *Ophrys* sp. And also the taxons of *Leucojum aestivum,*

Strenbergia lutea, Gladiolus italicus and *Iris pseudacorus* in the LC endangerment category in Tekirdag bulbous plants.

When we examine the geophytes of Sarıyer according to their design characteristics; it is found out that there are mostly white and yellow flowers in the native flora. And also it has been examined that there is only single taxon in the groups of yellowish green and multicolored flowering ones. *Galanthus* sp. and *Allium* sp. species can be a good example for white flowering species and *Narcissus* sp. and *Ranunculus* sp. species can be given as examples of yellow-flowered species. Geophytes bloom mostly in the spring months and mainly in March and April. It is seen that they stay flowering mostly about 2-3 months. However geophyte taxa are usually short (46,41%) and fine textured (59,18%).

The study of Zencirkıran et al. (2018) which was about the geophyte taxa of Kocaeli province, it was found out that mostly white flowering taxa were in the region. And then yellow, purple and pink flowering taxa were mostly found. On the other hand Seyidoğlu et al. (2009) has said that when we use the geophytes in landscape designs, preferring the short and short flowering species can be preferred in the drifts will be more effective and will achieve a natural appearance.

Conclusion

As a result, Sarıyer district has an importance in terms of geophyte taxa because of its different habitats, climatic properties and its situation in the urban ecology of Istanbul. Geophyte taxa can be used in many areas in the urban landscape such as rock gardens, lawn, bordure etc. Also geophytes constitute an integral part of the flora tourism within their beauty as well as their participation in landscape design with other herbaceous species. For gaining the geophyte taxa to the urban landscape, it is necessary to protect them in their natural areas and its necessary to carry out work related to this issue. Also in the scope of flora tourism, it is important to make flora trips for introducing the geophyte taxa in their own habitats.

According to the results obtained from this study, it is determined that geophytes are located mostly in forest and forest edge areas in Sarıyer region. It was found that they were found in shrubs and thirdly grassy and meadows areas. Based on these habitat areas with geofit species, it is recommended to organize nature walks, which are an important part of flora tourism. Belgrad Forest and edges and open spaces of the forest are very valuable areas in terms of being the habitats where Sarıyer geophytes are mostly located. For this reason, walking routes that will be arranged in a way to follow the flower colors and flowering times of the geofit taxa should be created in the Belgrad Forest and its surrounding. With the announcement of which plants will be observed during the hikes; attention of the nature lovers will be drawn to these environments. Thus, the floristic importance of the Belgrad Forest, which is one of the most important meeting points of nature lovers in Istanbul, will become even more impressive. On the other hand creating public awareness on behalf of the geophyte awareness and promote this wealth will be an appropriate approach. Especially an awareness can be obtained by seing the endangered species in their natural areas.

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