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Araştırma Makalesi
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Ruderal Plants in Urban and Sub-Urban Walls and Roofs

Kentsel ve Yarı Kentsel Alanlardaki Duvar ve Çatılarda Ruderal Bitkiler

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ABSTRACT

Objective: Main purpose of this study is to identify the ruderal plant species which spontaneously grows on the wall and roof surfaces in urban and sub-urban areas due to their limited ecological needs and to contribute to the creating of the sustainable green areas in urban environments by understanding the parameters that ruderals depend on while they require little maintenance and irrigation support if not no.

Material and Methods: The main material of this study is the ruderal plants which were collected from totally 60 walls and 36 roof surfaces within six districts of Trabzon city –Akçaabat, Arsin, Çaykara, Of, Ortahisar and Yomra in Turkey. From these 96 habitats, 1540 plants samples form the walls and 448 plant samples from the roofs were collected. All the plant samples collected from the research area were identified in the herbarium of the faculty of forestry in Karadeniz Technical University. Apart from this, parametres affecting coverage rate of common species on three different habitats were analysed.

Results: It was found that 448 samples from the roof surfaces distributed into 61 species while 1540 samples from the walls distributed into 196 species. Plus, according to the analyses, 28 species were found on all three different habitats. As a result of the observations, measurements and analyses, it is clear from the study that coverage rate of the plant species depends on anthropogenic interaction, daylight period and depth of the media but there is no relation with the number of the species on the surfaces.

Conclusion: Ruderal plants are definitely important to study on, if the world wants the term sustainability to find its real meaning as they require nearly nothing to grow in hard conditions. In urban life, maintenance is getting more and more expensive for green areas in urban life and this makes it difficult for them to survive especially when cities have limited budget on this, which has often occurred all over the world recently. There is no doubt that ruderal plants offer a great opportunity for modern era urban areas with their limited needs to grow in hard conditions. Furthermore, when thinking about the fact a serious amount of the ruderal plants detected on all three basic habitats has a great landscape plant characteristics, the approaches to their usage in urban areas are really critical.

ÖZ

Amaç: Bu araştırmanın amacı kentsel ve yarı kentsel alanlardaki duvar ve çatılarda, sınırlı ekolojik isteklerle varlıklarını sürdürebilen ruderal bitkilerin tespitinin yanı sıra ekolojik olarak sorunlu alanların (orta refüj, sanayi ve çöp alanları… vb.) yeşillendirilmesi ve kent ekolojisine kazandırılması açısından, ruderal bitkilerin gelişimine ve kaplama yoğunluğuna etki eden etmenlerin belirlenmesidir.

Materyal ve Metot: Araştırmanın bitkisel materyalini Trabzon ili'nin Akçaabat, Ortahisar, Yomra, Arsin, Of ve Çaykara ilçelerinden seçilen, toplam 60 duvar ve 36 çatıdan toplanan bitkiler oluşturmaktadır. Toplam 96 örnek alanından, duvarlardan 1540, çatılardan 448 olmak üzere 1988 bitki numunesi toplanmıştır. Toplanan bitkiler KTÜ herbaryumunda teşhise uygun halde kurutulduktan sonra teşhisleri yapılmış ve istatistiki analizlerle üç farklı ekolojik alanda ortak bulunan türlerin kaplama yoğunluklarının bağlı oldukları parametreler araştırılmıştır.

Bulgular: Çatılardan toplanan 448 bitki numunesi 61 farklı tür ile alanda yayılış gösterirken, duvarlardan toplanan 1540 bitki numunesinin ise 196 farklı tür ile yayılış gösterdiği belirlenmiştir. Araştırma alanında belirlenen 28 türün her üç farklı habitatta yayılış gösterdiği belirlenmiştir. Yerinde yapılan gözlemler ve ölçümler sonucunda bitkilerin kaplama yoğunlukları belirlenmiş olup, sonrasında yapılan istatistiki analizler sonucunda bitkilerin kaplama yoğunlukları alanların maruz kaldıkları antropojen etki, güneşlenme süreleri ve besin ortamı derinliğine bağlı olarak farklılıklar gösterirken, tür sayısının kaplama yoğunluğu üzerine etkisi olmadığı gözlemlenmiştir.

Sonuç: Sürdürülebilir yeşil kavramının daha anlamlı hale gelebilmesi için üzerinde çalışılması gereken en önemli konulardan biri de ruderal bitkilerdir. Kent hayatında bakım giderlerinin gittikçe önem kazandığı ve yaşam koşullarının her anlamda güçleşmektedir. Kent hayatında güçleşen bu şartlara adapte yeteneği oldukça üst düzeyde olan ruderal bitkilerin anlaşılması, karakteristiklenin ortaya konulması ve mümkünse çok daha az bakım desteği için kentlerde kullanılan bitkisel materyale destek sağlamasının mümkün kılınması modern dönem kentleri için atılabilecek en önemli adımlardan biri olacaktır. Yapılan araştırma sonucunda her 3 habitat için, ruderal bitkilerin gelişimlerinin ve kaplama yoğunluklarının antropojen etki ile ters orantılı, besin ortamı derinliği ve güneşlenme süreleri ile ise doğru orantılı olduğu belirlenmiştir. Araştırma alanında tespit edilmiş ortak türlerin ciddi bir kısmının peyzaj bitkisi olarak da değerli olabilecek türler olduğu düşünüldüğünde, bu türlerin kent peyzajlarında kullanılmalarına yönelik eğilimlerin oldukça anlamlı olacağı açıktır.

INTRODUCTION

Considering habitats within the context of ecological criteria, the habitats of herbaceous plants can be grouped as "Natural, Degraded, Ruderal and Artificial" (Hamel and Danserau, 1949; Yarcı and Altay, 2016). Ruderal habitats are inhabited by mostly nitrophilous plants that develop on specific areas such as weathered areas, ruins and wall sides (Doğan et al., 2004; Altay and Karahan, 2017). Ruderal habitats may vary depending on the substrates of existing roads, transported soils and compacted rocks with different sizes (Frenkel, 1977). Ruderal plants growing in these habitats were also referred to as pavement plants, underfoot plants and stepable plants in various studies from Europe (Sukopp and Witting, 1998; Karahan et al., 2012).

Ruderal plants usually have a short life-span, propensity for rapid growth and reach their maximum reproductive capacity during the vegetation period (Pianka, 1970; Karaköse et al., 2018). Moreover, their single reproductive cycle, the high sensitivity of their seeds, the dispersion of their seeds to favorable and distant regions and their phenological flexibility help their adaptation to a wide range of environmental conditions (Sakai et al. 2011). They are usually distributed in non-competitive, disturbed areas; in other words, they can distribute in habitats that are non-stationary during the early successional stages of vegetation. They especially prefer regions with high rainfall and humidity (Karaköse et al., 2018).

The studies about ruderal vegetation types are rather new. As are natural communities, which are characterized by natural conditions, sub-urban communities are characterized by the conditions of inhabited areas (Hadac, 1978). Hence, ruderal vegetation is of great importance considering the industrialization of villages and the consequent destruction of the natural and semi-natural vegetation in these areas. In future, ruderal communities will be further needed as an indicator of the environmental conditions for the utilization of synanthropic vegetation (Şafak, 2015; Çetin and Mansuroğlu, 2018).

Determining the function of ruderal communities is not an easy task. Their effects are not thoroughly known and their quantitative measurement is a very challenging process. Ruderal vegetation has both positive and negative aspects (Hadac, 1978). Ruderal plants can easily colonize open soils and resist to erosion, are mostly nitrophilous and thus, can retain a significant amount of water and nitrate in soils. This is a considerably beneficial process due to its contribution to the inhibition of eutrophication in water basins. Furthermore, ruderal plants are cosmopolitan plants that are resistant to competition, their seeds can be dispersed even by car tires, they easily adapt to new environments, form ecotones, rapidly form large amounts of seeds, also referred to as pioneer plants, their seeds require a limited amount of nutrients for germination, they have rapidly growing roots and have the ability to form mycorrhizae (Anonymous, 2018a, 2018; Erik, 2012; Kılınç and Kutbay, 2008; Rentch et al., 2005; Heindl and Ulmann, 1991; Frenkel, 1977).

The studies about plant sociology became widespread in Turkey in the 1960s and thus far, numerous plant communities from different vegetations types were identified (Ketenoğlu et al., 2014). However, in Turkey, there are hardly any studies about ruderal vegetation, which is a broadly distributed vegetation type in urban ecosystems and regarded as a special type of vegetation (Yarcı and Altay, 2016; Altay, 2009; Güney et al., 2006; Çelik et al., 1998;).

There is little knowledge about these plants that characterize urban areas in which the majority of the world population reside. Therefore, there is a tremendous need for studies about ruderal plants to better understand cities. In light of this need, we came to conclude that investigating the special habitats that are specific to cities may yield interesting results and accordingly, the study was commenced. Walls and roofs, two urban habitats that do not exist in nature under normal circumstances and by their mere existence, prove the disturbance caused by humans comprise the growing environments that will be discussed in detail in the study. Within this scope, a study was carried out to identify the ruderal plant communities that are potentially distributed in the roof and wall vegetations. To compare and reveal the similarities and differences between urban ruderal vegetations, 30 sample areas that were selected among sub-urban areas were also included in the study. Considering the last 20 years, this was deemed necessary mostly due to the potential transformation of today's urban areas in many regions of the world into urban areas in near future. The study can thereby contribute to the detailed phytoecological and phytosociological studies about ruderal habitats in near future.

MATERIAL and METHOD

Study Area

The study areas consist of Akçaabat, Ortahisar, Yomra, Arsin, Of and Çaykara, which are towns of Trabzon City, Turkey, according to administrative boarders (Figure 1). The highest rate of urbanization is observed in Ortahisar in addition to its geographic location in the middle of the shoreline, which adds to its importance. The coastal region to the west of the town was examined by choosing Akçaabat as the representative of the region, while Yomra, Arsin and of were regarded as the representatives of the eastern region and Çaykara was regarded as the representative of the high inlands where the shore effect is relatively reduced. Location selection was carried out in this manner to ensure the examination of the entirety of the characteristics of different locations that are likely to be observed across the city. Trabzon is located between the slopes facing the north-west of the Kalkanlı mountainous mass in the middle of the arc formed by the Eastern Black Sea Mountains, at 38°30'-40°30' E and 40°30'-41°30' N (Anonymous, 2018b). Trabzon covers an area of approximately 4.685 km^2 and has a population of about 758.237, making it the second largest principal city in the region. The city is within the A8 of the grid system created by Davis 1965 and Davis 1988 and the annual mean rainfall is about 760 mm, while the mean temperature is about 14.6 C°. The monthly mean temperature ranges from 7.3 C° in January and from 13 to 23.1 C° in August (Yalçınalp and Meral, 2017).

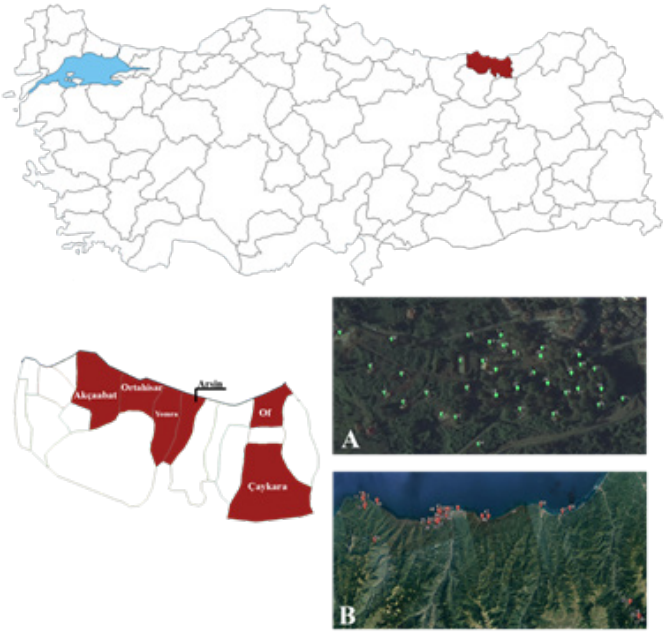


Figure 1. Study areas (A: Sample areas for the roof plants, B: Sample areas for the wall surfaces)
Şekil 1. *Çalışma alanları*

Method

Sample Collection

The study materials comprise the samples that were collected from 96 different areas after the wall and roof vegetation studies carried out in Trabzon during the period between 2013 and 2015. Among the 1540 samples (196 species) collected from the walls and 448 samples (61 species) collected from the roofs, 28 species that were commonly identified in both walls and roofs were classified according to the Grime's plant strategies (S, R, C) and included in the study. The plants were pressed and dried by following the standard herbarium methods and turned into herbarium materials. The plant species collected from the sample areas were identified using the Turkey Flora Index of the Herbarium of Karadeniz Technical University (Önen, 2015; Yüzbaşıoğlu, 2014; Eminağaoğlu et al. 2012; Coşkunçelebi et al., 2007; Terzioğlu et al., 2003; Güner et al., 2000; Terzioğlu and Anşin, 1999). The current status of the identified plants in the flora of Turkey was verified using the Turkey Plant List prepared by Güner et al., 2012. Raunkiær (1937) classified plants according to the place where the growth point is located during the less favorable seasons, provided the plant maintains the capability to survive these difficult conditions. The life-forms of the ruderal plants were determined in accordance with the system proposed by Raunkinaer, 1937.

Data Analysis

The analyses are based on the observations made of the plants that grew in the habitats in the study areas during the vegetation period between 2013 and 2015. The statistical analyses were performed using the SPSS Statistics 17.0 package program. In this study, Duncan and Regression analyses were performed to understand if there are meaningful differences between three different habitats and if there are hierarchical relations between the plant coverage rates on the wall and roof surfaces and the parameters affecting them.

RESULTS

Ruderal vegetation is a special type of synanthropic vegetation, which is the plant cover adapted to the conditions of residential areas that change due to anthropogenic factors (Figure 2) (Şafak, 2015).

For the further utilization of synanthropic vegetation in future, ruderal communities will be more needed.

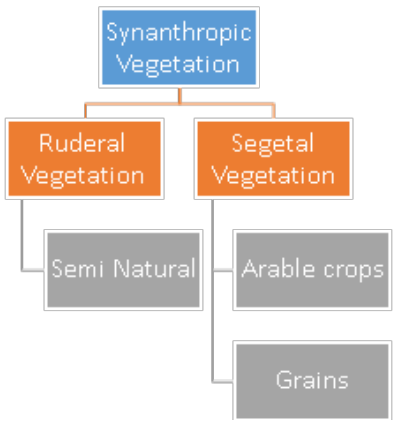


Figure 2. Ruderal vegetation and other similar vegetation types (Erik, 2012)
Şekil 2. *Ruderal vejetasyon ve y akın olduğu vejetasyon tipleri (Erik, 2012)*

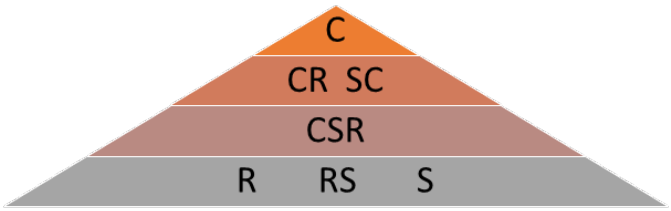
The vegetation comprising the ruderal plants in the study area was determined to be cosmopolitan and resistant to competition; plants with distinctly different ecological needs cohabited the area: their seeds were transported in various ways; plants easily adapted to the environment and created ecotones, rapidly formed large number of seeds, had the ability to form mycorrhizae; most importantly, their seeds had a considerably low nutrient requirement for germination (Table 1).

A total of 28 species from 18 different families were observed in the study area. Among the 28 species, 14 (50%) showed natural dispersion, while the remaining 14 (50%) do not show natural dispersion in Trabzon. The life-forms of the 28 species include *Hemicryptophytes* (15 species; 53.57%), *Phanerophytes* (6 species; 21.43%), *Cryptophytes* (3 species; 10.72%), *Chamaephytes* (2 species; 7.14%), Geophytes (1 species; 3.57%) and *Therophytes* (1 species; 3.57%) (Table 1).

Table 1. Common ruderal plant species in the study areas
Çizelge 1. *Araştırma alanlarında ortak rastlanan ruderal bitki türleri*

	Family	Species
1	***Aceraceae***	*Acer negundo*
2	***Apiacea***	*Daucus carota*
3	***Asteraceae***	*Bidens tripartite*
4		*Canyza Canadensis*
5		*Cichorium intybus*
6		*Cirsium trachylepis*
7		*Sonchus asper*
8		*Tanacetum partherium*
9		*Taraxacum buttleri*
10	***Caprifoliaceae***	*Sambucus ebulus*
11	***Caryophllaceae***	*Stellaria media*
12	***Cornacea***	*Cornus sanguiena*
13	***Euphorbiaceae***	*Euphorbia peplus*
14	***Fabaceae***	*Robinia pseudoacacia*
15	***Geraniaceae***	*Geranium purpureum*
16	***Lamiacea***	*Calamintha nepeta*
17	***Moraceae***	*Ficus carica*
18	***Oleaceae***	*Fraxinus angustifolia*
19	***Oxalidaceae***	*Oxalis corniculata*
20	***Primulaceae***	*Anagallis arvensis*
21	***Ranunculaceae***	*Clematis vitalba*
22	***Rosaceae***	*Agrimonia eupatoria*
23		*Cotoneaster figida*
24		*Geum urbanum*
25		*Rubus conhescens*
26	***Simaroubaceae***	*Ailanthus altissima*
27	***Urticaea***	*Parietaria judaica*
28		*Urtica dioica*

Areas with limited nutrients are similar to natural rocky areas (Jim, 1998). Hence, the plants in the study area were classified as RS (Ruderal-Stress tolerators) according to the Grime's C-S-R model (Figure 3).



C: *Abandoned, high-productivity areas, e.g. streamside*
CR: *Abandoned meadows*
SC: *High-productivity, disturbed areas, e.g. fertilized areas*
CSR: *Humid meadows*
R: *Abandoned, low-productivity meadows*
RS: *Disturbed, low-productivity areas, e.g. rocks*
S: *Disturbed fields*

Figure 3. Grime's C-S-R triangle (Şafak 2015)
Şekil 3. *Grime 'nin C-R-S üçgeni (Şafak 2015)*

The measurements in the study areas showed that the mean vegetation cover was 56.54% on the roofs, 29.37% on the walls in the sub-urban areas and 25.55% on the walls in the urban areas.

According to the One-Way ANOVA test performed for the study area with a confidence interval of 95%, there were significant differences between the areas selected for the study (Table 2).

Table 2. One-Way ANOVA test for the cover density in the study areas
Çizelge 2. *Çalışma alanlarında belirlenen bitki kaplama yoğunlukları için yapılan One-Way ANOVA testi*

ANOVA

Cover density

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	17543.558	2	8771.779	14.862	.000
Within Groups	54888.196	93	590.196		
Total	72431.754	95			

The Duncan test performed after the one-way ANOVA test revealed that although there were no significant differences between the walls in the urban and sub-urban areas in terms of vegetation density, the vegetation density of the walls and roofs was significantly different (Table 3). This is attributable to the easier retention of nutrient medium and water in roofs due to the horizontal elongation of the walls and their more favorable conditions for seed germination.

The one-way ANOVA test performed for the study area with a confidence interval of 95% showed that there were no significant differences between the number of species in the areas selected for the study (Table 4).

Table 3. Duncan test for the cover density in the study areas
Çizelge 3. *Çalışma alanlarında belirlenen bitki kaplama yoğunlukları için yapılan Duncan testi*

Duncan[a,,b]			
Urban Walls- Sub-urban Walls- Roofs	N	Subset for alpha = 0.05 1	2
2	30	28.03	
1	30	29.87	
3	36		56.83
Sig.		.764	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31.765.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table 4. One-Way ANOVA test for the number of species in the study areas
Çizelge 4. *Çalışma alanlarında belirlenen tür sayıları için yapılan One-Way ANOVA testi*

ANOVA
Number of Species

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.412	2	.706	1.093	.340
Within Groups	60.078	93	.646		
Total	61.490	95			

Despite the significant differences between the vegetation density on walls and roofs, the Duncan test showed that there were no significant differences between the number of species in different sample areas. Thus, it can be argued that the cover density in the study areas did not differ depending on the number of species.

The one-way ANOVA test performed for the study area with a confidence interval of 95% revealed that there were significant differences in anthropogenic effects in the areas selected for the study (Table 5).

Table 5. One-Way ANOVA test for the anthropogenic effects in the study areas
Çizelge 5. *Çalışma alanlarında belirlenen antropojen etkiler için yapılan One-Way ANOVA testi*

ANOVA
Anthropogenic effects

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	95.855	2	47.928	37.727	.000
Within Groups	118.145	93	1.270		
Total	214.000	95			

The Duncan test performed for the anthropogenic effects showed that there were significant differences between the three sample areas in terms of anthropogenic effects. Thus, it can be argued that anthropogenic effects were an important factor in the differences between the vegetation density of the sample areas (Table 6).

Table 6. Duncan test for the anthropogenic effects in the study areas
Çizelge 6. *Çalışma alanlarında belirlenen antropojen etkiler için yapılan Duncan testi*

Duncan[a,,b]				
Urban Walls- Sub-urban Walls- Roofs	N	Subset for alpha = 0.05 1	2	3
3	37	.30		
2	29		1.86	
1	30			2.63
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31,631.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

According to the one-way ANOVA test performed for the study area with a confidence interval of 95%, although there were no significant differences between the sunshine duration of the urban walls and roofs in the areas selected for the study, there were differences between urban walls and other two sample areas (Table 7).

Table 7. One-Way ANOVA test for the sunshine durations in the study areas
Çizelge 7. *Çalışma alanlarında belirlenen güneşlenme süreleri için yapılan One-Way ANOVA testi*

ANOVA
Sunshine durations

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21.584	2	10.792	9.709	.000
Within Groups	103.374	93	1.112		
Total	124.958	95			

The examination of sunshine durations revealed that while there were no significant differences between the walls and roofs selected from the urban locations, the wall selected from the sub-urban location received less sunlight than the two areas (Table 8). On-site observations revealed that because of the lower vegetation of tall trees in the urban areas than that in the sub-urban areas, sunlight was only blocked by a limited number of tall trees and buildings in the urban areas, whereas it was frequently blocked both by the tall trees and buildings in the sub-urban areas.

Table 8. Duncan test for the sunshine durations in the study areas
Çizelge 8. *Çalışma alanlarında belirlenen güneşlenme süreleri için yapılan Duncan testi*

Duncan[a,,b]			
Urban Walls- Sub-urban Walls- Roofs	N	Subset for alpha = 0.05 1	2
1	30	1.23	
3	37		2.03
2	29		2.41
Sig.		1.000	.148

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31,631.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

The one-way ANOVA test performed for the study area with a confidence interval of 95% showed that the depths of the nutrient media in the areas selected for the study were significantly different from each other (Table 9).

Table 9. One-Way ANOVA test for the nutrient medium depths in the study areas
Çizelge 9. *Çalışma alanlarında belirlenen besin ortamı derinlikleri için yapılan One-Way ANOVA testi*

ANOVA

Nutrient medium depths

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	33.368	2	16.684	36.973	.000
Within Groups	41.965	93	.451		
Total	75.333	95			

The Duncan test showed that there were significant differences in the medium depths of all three sample areas (Table 10).

Table 10. Duncan test for the nutrient medium depths in the study areas
Çizelge 10. *Çalışma alanlarında belirlenen besin ortamı derinlikleri için yapılan Duncan testi*

Duncan[a,b]

		Subset for alpha = 0.05		
Kır-Kent-Çatı	N	1	2	3
2	29	.69		
1	30		1.07	
3	37			2.05
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 31,631.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

DISCUSSION and CONCLUSION

Ecological studies about cities already fall short of understanding cities both quantitively and qualitatively, which is worsened by the ever-changing structure of the concept of city. This renders studies about cities even more important. Ruderal plants are among the most important subjects that require further research both to better understand cities and attach more significance to the concept of sustainability.

In times of constant information flow about the urban areas' gradual departure from habitability, more and more importance is attached to the sustainability concept. Sustainability in cities is an exhaustive term that involves tens of different components such as rainwater management, heat island effect, cycles of various materials such as carbon and nitrogen and pollination and plants have important roles in all of these components. Although this is not a major problem in sub-urban areas, urban areas indicate habitats that are hard to adapt to for many plant species. In addition, the green areas in sub-urban areas are frequently replaced by floor coverings and roofing in urban areas, which turn urban areas into problem areas in terms of various ecological parameters. Hence, as species with high adaptability to the conditions of urban areas where maintenance costs are becoming more important and living conditions are getting worse, a further insight into ruderal plants, revealing their characteristics and using them as the support material for the plant materials used in cities to, if possible, minimize the need for maintenance will be among the most important steps taken for modern cities. A noteworthy portion of the common species that were identified in the study area can also be utilized as landscaping plants and thus, creating a preference for their use in urban landscaping will prove fruitful. The use of expensive and non-sustainable methods to sustain the plant materials used on almost all human-made green walls instead of *Parietaria Judaica,* which is a taxon referred to as "pellitory of the wall" in the scientific literature and thrives on walls in many regions of the world despite the far from ideal conditions of walls in terms of water and nutrient supply, is quite ironic. Rather than using non-sustainable and expensive methods to facilitate the conditions for the exotic species used on green walls and green roofs use of which emerged in response to sustainability and global climate change channeling the ruderal plant resources, which are already available in urban areas and have the capacity to compete, to these areas is a more ecofriendly approach.

As a dynamic group characterized by their resistance to ever-changing conditions, ruderal plants can be regarded as a part of the urban areas' richness in biodiversity. Although degraded areas are the reason of their existence, considering the dynamics of cities, other plants are unlikely to exist in areas where ruderal plants are not already present and therefore, the presence of ruderal plants in areas where maintenance is not necessary or expensive implies an automatic increase in biodiversity. An uninhabitable living area even for ruderal plants means that area is exhausted to its limits and thus, ruderal plants can also be viewed as an indicator of the not yet diminished potential of urban ecosystems to support organic life.

The differences and similarities between the ruderal plants in sub-urban areas and urban areas also have an important potential to shape the future of cities. Especially the sub-urban areas in developing countries are candidate urban areas and therefore, the examination and prospective interpretation of the dynamics in these areas will greatly contribute to our understanding of urban ecosystems. These areas harbor urban dynamics in a lesser degree and determining where the ecological differences-induced similarities and differences between the ruderal vegetations in the two areas start and end will enable the suburbanization of the urban areas through the use of ruderal plants and thus, result in the start of a comeback for urban areas.

Although the one-way ANOVA and Duncan tests with a confidence interval of 95% indicated that there were no significant relationships between the number of species and medium depths in the sample areas, significant relationships

were found between anthropogenic effects and nutrient medium depths. The regression analysis performed after these tests showed that anthropogenic effect and nutrient medium depth were the most effective parameters on cover density (Table 11).

Therefore, it can be concluded that medium depth is the most important parameter to be supplied to improve the ecological parameters in urban areas through the use of ruderal plants. Nutrient medium depth was revealed to be the most important parameter, since the plants tolerated and adapted to other conditions. From this point of view, creating small niches to allow the adherence of nutrient media in the hard surfaces used in the landscape design while also taking the physical integrity of the construction and visual quality into account can greatly contribute to the relief of the cities of the green infrastructure load. Using roof tiles that contain small pockets as roof covering, preferring pocket-containing materials as wallcovering, using rocks with large pores and constructing wide cracks for drainage are exemplary ways to create niches for this purpose.

Table 11. Regression analysis for the study area
Çizelge 11. *Çalışma alanındaki bitki kaplama yoğunluğunun belirlenmesi için yapılan Regresyon analizi*

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3.001	.344		8.724	.000
	Number of species	-.159	.142	-.092	-1.125	.264
	Anthropogenic effects	**-.427**	**.078**	**-.461**	**-5.475**	**.000**
	Nutrient medium depths	**.569**	**.137**	**.369**	**4.164**	**.000**
	Sunshine durations	**-.218**	**.095**	**-.181**	**-2.295**	**.024**

a. Dependent Variable: Cover density

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