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An ignored habitat in Türkiye: Sandy steppe

Ergin HAMZAOĞLU[1*], Kuddisi ERTUĞRUL[2], Murat KOÇ[3]
[1]*Gazi University, Gazi Education Faculty, Department of Mathematics and Science Education, Ankara, Türkiye*
[2]*Selçuk University, Science Faculty, Department of Biology, Konya, Türkiye*
[3]*Ankara Yıldırım Beyazıt University, Public Health Institute, Department of Traditional, Complementary and Integrative Medicine, Ankara, Türkiye*
**erginhamzaoglu@gazi.edu.tr, [2]kuddisiertugrul@gmail.com, [3]aybumuratkoc@hotmail.com*

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Türkiye'de yok sayılmış bir habitat: Kumlu bozkır

Abstract: The steppes habitat in Türkiye took bedrock formed of soil as the basis, and was classified by separating into groups, such as calcareous, with gypsum, volcanic, and serpentine. However, a classification was not made that took the soil texture as the basis. In this study, the stable sand dunes' soil texture observed in Karapınar, Konya, Türkiye erosion region, was evaluated for flora and syntaxonomy. Within the scope of the study, observations were conducted in the sandy habitats found to the south-southwest of the Karapınar county center, the plant species that preferred the habitat were determined, and the data obtained was compared with the steppes' habitat in the close environs and with the studies made previously. Furthermore, it emphasized the necessity of analyzing syntaxonomically the sandy steppes in Turkey, which are evaluated within the "E1.A5 - Irano-Anatolian inland dunes" habitat type according to the European Nature Information System (EUNIS).

Key words: Central Anatolia, Habitat classification, sandy flora, sandy soil, steppe, vegetation

Özet: Türkiye bozkır habitatı; toprağı oluşturan ana kayaç esas alınarak kireçli, jipsli, volkanik, serpantin vs. gibi gruplara ayrılarak sınıflandırılmış, ancak toprak bünyesini esas alan bir sınıflandırma yapılmamıştır. Bu çalışmada Karapınar (Konya, Türkiye) erozyon bölgesinde gözlenen durağan kumullar toprak bünyesi, flora ve sintaksonomi bakımından değerlendirilmiştir. Çalışma kapsamında Karapınar ilçe merkezinin güney-güneybatısında bulunan kumlu habitatlarda gözlemler yapılmış, habitatı tercih eden bitki türleri tespit edilmiş, elde edilen veriler yakın çevresindeki bozkır habitatı ve daha önce yapılmış çalışmalarla karşılaştırılmıştır. Ayrıca Avrupa Doğa Bilgi Sistemine (EUNIS) göre "E1.A5 - Irano-Anatolian inland dunes" habitat tipi içinde değerlendirilen Türkiye kumlu bozkırlarının sintaksonomik açıdan analiz edilmesinin gerekliliği vurgulanmıştır.

Anahtar Kelimeler: Bozkır, habitat sınıflandırması, İç Anadolu, kumlu flora, kumlu toprak, vejetasyon

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1. Introduction

Studies for the classification of vegetation started in the first half of the nineteenth century (Humboldt and Bonpland, 1814; Grisebach, 1838). In these studies, vegetation was considered in a general manner and classified based on physiognomy. From the beginning to the present-day, vegetation classification methodology has gradually been developed, and new classification techniques and schools have been formed based on different characteristics of vegetation (Whittaker, 1973; Mucina, 1997). The data obtained from the vegetation classifications, currently constitutes the basis of the habitat classification. For example, the European Nature Information System (EUNIS) is an original and dynamic system that classifies all the natural or artificial habitats in Europe (Evans, 2012).

If the studies are not considered that were conducted separately from each other, the regular studies related to the vegetation of Türkiye were started by Prof. Dr. Hikmet Ahmet Birand in the 1930s (Handel-Mazetti, 1909; Schwarz, 1936; Czeczott, 1939; Krause, 1940; Gür, 2010). These studies accelerated as of the 1970s with the efforts of numerous Turkish and foreign scientists. As a result of these intensive studies, a considerable number of plant communities, especially forest and steppe vegetations, were identified, mostly in central, south, west and north of Anatolia and partially in the east (Ketenoğlu et al., 2010; Özdeniz, 2017). However, unfortunately, the vegetation studies in Türkiye have slowed down, and even came to a standstill at the beginning of 21st century, though there are many areas without any vegetation data, especially in the southeast and east Anatolia.

Since the vegetation studies in Türkiye remained unfinished and were not matched with habitats, the obtained data could not be transferred to an EUNIS-like system as in Europe. Furthermore, despite conducting studies, it can also be said that detailed classification has not been made for some habitats in Turkiye and it has been handled in a very general manner. For example, the salt marsh habitat has been evaluated within the steppes' habitat for an extensive period and the salt marsh and salt steppe differentiations were made approximately 40 years later (Birand, 1961; Aydoğdu et al., 2002; 2004).

Sandy steppe is another habitat type has not been differentiated until now. In Türkiye, the steppe is classified into groups such as calcareous, gypsum, volcanic, serpentine, etc., based on the bedrock that forms the soil (Özdeniz, 2017). But a steppe classification based on soil texture has not been made. However, with its soil texture and flora, sandy steppe habitat is different from all known steppe types in Türkiye. The most significant feature that separates the sandy steppes' habitat from the other steppe varieties is the texture of the soil that develops on it. The

particles that make up the soil with a size between 2.0-0.02 mm are grouped as sand, those between 0.02-0.002 mm as silt, and those with a size less than 0.002 as clay (Aydın and Kılıç, 2010). According to accepted international standards, soils containing more than 68% sand and less than 18% clay in the first 100 cm of solum are classified as sandy (ISSS Working Group RB, 1998). Since sandy soils have larger interparticle spaces, water drainage is faster and water holding capacity is low. They are poor soils in terms of nutrients due to excessive washing in the solum. Generally they have an acidic, dry, and light character. On the other hand, they have better aeration and faster heat exchange compared to silty and clay soils. However, since they heat up rapidly, they become dry quickly in the summer (Özen and Onay, 2018; Okur et al., 2021).

Psammophytes are special plants that have adapted to living in sandy soils. Sand dunes, which are formed as a result of the accumulation of sand particles blown with the effect of wind, are not suitable for plant life, especially due to their low water holding capacities. To get rid of this negativity, perennial psammophytes have adapted to give new shoots from the underground parts of their roots and stems. In some species, the leaves are either absent or rather narrowed to minimize water loss. Like therophytes, living in only one suitable season, is also an another adaptation. Therophytes only germinate during the rainy season, give flowers and finally die, leaving seeds. Precipitation is the most important source of water in arid and semi-arid sandy areas. It is also the most fundamental factor that ensures the formation and development of a psammophyte community (Wilhelmi and Wilhite, 2002).

Depending on the sandy soil on which they live, psammophyte communities are classified as drift lines, mobile dunes, stabilized dunes and salt marshes (Mahdavi et al., 2017). Stabilized dunes are habitats where the sand does not move with the wind, but remains stable. In Europe, the sandy steppe vegetation that develop on stabilized dunes has been attributed to class *Koelerio-Corynephoretea canescentis* Klika in Klika et Novák 1941 (Mucina et al., 2016). This class includes primary plant communities that develop on sandy soils and shallow soils that cover rocky areas that are often degraded by erosion, animal or human activities. No syntaxon has been identified so far in Türkiye that belongs to this class. The syntaxa, identified in the steppe vegetation of Türkiye, were assigned to the class *Astragalo-Brometea tomentelli* Quézel 1973 (Özdeniz 2017). In this study, the stabilized dune habitat observed in the Karapınar (Konya) erosion zone was evaluated by considering the soil texture, flora and syntaxonomy, compared with the steppe habitats in close environ, and the existence of sandy steppe habitat in Türkiye was discussed.

2. Material and Method

This study aims to reveal the existence of the "sandy steppe" habitat in Türkiye. For this purpose, observations were made on 28.6.2018 in the sandy steppe habitat located at south-southwest of Karapınar (Konya, Türkiye) district center (Fig. 1). The data obtained as a result of the observations, the determined plant samples and the previous vegetation researches carried out in the region constitute the material of the study (Birand, 1970; Bağcı et al., 1996). The methodology of the study was based on the comparison the comparison of the studies carried out in the Karapınar sandy steppe habitat with the sandy-loam or clay-loam steppe habitat in the close environs in terms of soil texture, flora and syntaxonomy. As the soil texture, the international standard, which considers soils containing more than 68% sand and less than 18% clay in the first 100 cm of the solum, as "sandy soil" were regarded (ISSS Working Group RB, 1998). The identification and phytogeographical designation of the vascular plants recorded in the area were done according to Davis (1965-1985) and other resources (Davis et al., 1988; Güner et al., 2000). The determined plant species detected during field observations were regarded as flora, and syntaxons to which the Turkish steppe habitat and the European sandy steppe habitat were attributed, were regarded as syntaxonomy (Mucina et al., 2016; Özdeniz, 2017).

2.1. Brief description of the study area

Karapınar district is located Konya province in the southern part of central Anatolia (Turkiye). There are sandy areas formed by wind erosion about 5 km south-southwest of the district center (Fig. 1). The elevations in the area range between 1000 and 1060 meters. There are no lakes or streams in the area. As a result of wind erosion and the anthropogenic effects in the region, sandy steppes remained as patches among salt marshes and other steppes. The soil data related to Karapınar erosion zone were obtained from previous studies carried out in the area (Birand, 1970; Bağcı et al., 1996). The area is dominated by alluvial and regosol soils. In these soils, the sand ratio varies between 40-80% and the clay ratio varies between 7-25% (Birand, 1970; Bağcı and Dural, 1997).

The climatic data of Karpınar erosion zone was obtained from Konya meteorological station. The average annual temperature of Konya province is 11.7 °C. The highest and lowest temperatures are observed in July and January with 23.5 and -0.2 °C. The highest rainfall in Konya takes place in May and December with 43.1 and 43.2 mm respectively. The lowest rainfall is observed in August and July with 6.4 and 7.5 mm (MGM, 2022). These values indicate that Karapınar erosion zone is dominated by “semi-arid very cold Mediterranean” climate (Akman, 1999).

3. Results

Two basic plant communities were determined during the observations conducted on 28 June 2018 in the stabilized dune habitats of the Karapınar (Konya) erosion region. The first one is observed in the relatively rough terrain around Örnektepe, and is characterized by the dominance of the

Figure 1. Karapınar erosion zone and Örnektepe (adapted from “Google Earth Pro”)

Figure 2. *Alhagi maurorum* subsp. *maurorum* community around Örnektepe

Alhagi maurorum Medik. subsp. *maurorum* (Fabaceae) species (Fig. 2). The second is observed in almost flat areas in the south and southeast of Örnektepe, and is characterized by the dominance of *Stipa hohenackeriana* Trin. & Rupr. (Poaceae) species (Fig.3). A total of 75 species and infraspecies taxa were determined in these communities. Of these, 30 are Irano-Turanian and one is Mediterranean phytogeographic region element. In addition, 15 of these taxa are endemic to Türkiye (20% endemism).

Other common species in areas dominated by *Alhagi maurorum* subsp. *maurorum* are *Alkanna orientalis* (L.) Boiss. var. *orientalis*, *Anchusa leptophylla* Roem. & Schult. subsp. *incana* (Ledeb.) D.F. Chamb., *Anisantha tectorum* (L.) Nevski, *Artemisia campestris* L. subsp. *campestris*, *Astragalus matthewsiae* Podlech & Kirchhoff, *Bromus japonicus* Thunb. subsp. *japonicus*, *Centaurea pulchella* Ledeb., *Chondrilla juncea* L., *Cynanchum acutum* L. subsp. *acutum*, *Minuartia anatolica* Woronow var. *arachnoidea* McNeill, *Phleum boissieri* Bornm., *Poa bulbosa* L. and *Xeranthemum annuum* L. On the other hand, *Minuartia anatolica* Woronow var. *arachnoidea* McNeill, *Onosma roussaei* DC., *Haplophyllum vulcanicum* Boiss. & Heldr., *Centaurea pulchella* Ledeb., *Phleum boissieri* Bornm., *Cynodon dactylon* (L.) Pers., *Lomelosia argentea* (L.) Greuter & Burdet, *Artemisia campestris* L. subsp. *campestris*, *Xeranthemum annuum* L. and *Poa bulbosa* L. were found to be common in *Stipa hohenackeriana* dominated areas.

Figure 3. *Stipa hohenackeriana* community to the south and southeast of Örnektepe

3.1. The sandy steppe flora of Karapınar

Spermatophyta
Gymnospermae
Cupressaceae
Juniperus deltoides R.P.Adams

Angiospermae
Monocotyledonae
Amaryllidaceae
Allium myrianthum Boiss., Irano-Turanian element

Poaceae
Anisantha tectorum (L.) Nevski
Briza humilis M.Bieb.
Bromus japonicus Thunb. subsp. *japonicus*
B. tomentellus Boiss., Irano-Turanian element
Cynodon dactylon (L.) Pers.
Phleum exaratum Griseb.
Poa bulbosa L.
Stipa hohenackeriana Trin. & Rupr., Irano-Turanian element

Dicotyledonae
Amaranthaceae
Salsola kali L. subsp. *ruthenica* (Iljin) Soó

Apiaceae
Bupleurum sulphureum Boiss. & Balansa, Irano-Turanian element, endemic
Echinophora tenuifolia L. subsp. *sibthorpiana* (Guss.) Tutin, Irano-Turanian element
Eryngium campestre L. var. *virens* (Link) Weins
Ferulago armena (DC.) Bernardi, Irano-Turanian element, endemic

Apocyanaceae
Cynanchum acutum L. subsp. *acutum*

Asteraceae
Anthemis cretica L. subsp. *albida* (Boiss.) Grierson
Artemisia campestris L. subsp. *campestris*
Centaurea pulchella Ledeb., Irano-Turanian element
C. solstitialis L.
C. virgata Lam., Irano-Turanian element
Chondrilla juncea L.
Cirsium arvense (L.) Scop.
Cousinia birandiana Hub.-Mor., Irano-Turanian element, endemic
Crepis foetida L. subsp. *rhoeadifolia* (M.Bieb.) Čelak.
Crupina crupinastrum (Moris) Vis.
Cyanus depressus (M.Bieb.) Soják
Helichrysum plicatum DC. subsp. *plicatum*
Lactuca serriola L.
Tragopogon latifolius Boiss. var. *latifolius*, Mediterranean element
Xeranthemum annuum L.

Boraginaceae
Alkanna orientalis (L.) Boiss. var. *orientalis*, Irano-Turanian element
Anchusa leptophylla Roem. & Schult. subsp. *incana* (Ledeb.) D.F.Chamb., Irano-Turanian element, endemic
Lappula barbata (M.Bieb.) Gürke, Irano-Turanian element
Onosma roussaei DC., Irano-Turanian element

Brassicaceae
Alyssum strigosum Banks & Sol. subsp. *strigosum*
Camelina rumelica Velen.
Descurainia sophia (L.) Webb ex Prantl subsp. *sophia*

Erysimum crassipes Fisch. & C.A.Mey.
Isatis floribunda Boiss. ex Bornm., Irano-Turanian element, endemic
Meniocus linifolius DC.
Sinapis arvensis L.

Caryophyllaceae
Dianthus crinitus Sm.
Minuartia anatolica Woronow var. *arachnoidea* McNeill, Irano-Turanian element, endemic
Saponaria prostrata Willd., Irano-Turanian element, endemic
Silene conica L.
S. otites (L.) Wibel

Convolvulaceae
Convolvulus arvensis L.

Dipsacaceae
Lomelosia argentea (L.) Greuter & Burdet
L. rotata (M.Bieb.) Greuter & Burdet, Irano-Turanian element

Fabaceae
Alhagi maurorum Medik. subsp. *maurorum*, Irano-Turanian element
Astragalus lycius Boiss., endemic
A. matthewsiae Podlech & Kirchhoff, Irano-Turanian element, endemic
A. mesogitanus Boiss., Irano-Turanian element, endemic
A. microcephalus Willd., Irano-Turanian element
Hedysarum varium Willd., Irano-Turanian element
Medicago astroites (Fisch. & C.A.Mey.) Trautv., Irano-Turanian element
M. isthmocarpa (Boiss. & Balansa) E.Small, endemic
Onobrychis arenaria (Kit.) DC. subsp. *cana* (Boiss.) Hayek
O. tournefortii (Willd.) Desv., Irano-Turanian element, endemic

Lamiaceae
Ajuga chamaepitys (L.) Schreb. subsp. *chia* (Schreb.) Arcang. var. *chia*
Salvia absconditiflora Greuter & Burdet, Irano-Turanian element, endemic
S. ceratophylla L., Irano-Turanian element
Ziziphora tenuior L.

Papaveraceae
Papaver argemone L.

Plumbaginaceae
Acantholimon venustum Boiss. var. *venustum*

Ranunculaceae
Adonis flammea Jacq.
Nigella arvensis L. var. *glauca* Boiss., Irano-Turanian element

Resedaceae
Reseda lutea L. subsp. *lutea*

Rhamnaceae
Rhamnus hirtella Boiss., Irano-Turanian element, endemic

Rosaceae
Prunus orientalis Koehne, Irano-Turanian element

Rubiaceae
Galium aparine L.

Rutaceae
Haplophyllum vulcanicum Boiss. & Heldr., Irano-Turanian element, endemic

Scrophulariaceae
Verbascum cheiranthifolium Boiss. var. *asperulum* (Boiss.) Murb.

Zygophyllaceae
Tribulus terrestris L.

4. Discussions

The first study on xerophyte plant communities around Karapınar (Konya) was carried out by Birand (1970). In the study, the areas between Konya-Karapınar, south of Karapınar and between Karapınar-Ereğli were treated as two different habitats as "Die Sandwüste (sandy desert)" and "Artemisia-Steppe". A soil profile was taken from the habitat type called sandy desert and 22 relevé records were made. The soil between 0-110 cm of the soil profile is sandy, while loamy between 110-135 cm and 135-205 cm. The sand ratio of the soil in the range of 0-110 cm is given as 60.25%. Although he named it as sandy desert (die Sandwüste), the steppe habitat whose relevé records were made by Birand (1970) is not considered "sandy", according to international standards, since the proportion of sand is less than 68% (ISSS Working Group RB, 1998). When the recorded 22 relevé were examined, it can easily be seen that *Salvia cryptantha* Montbret & Aucher ex Benth. (current name *S. absconditiflora* Greuter & Burdet) and *Phlomis armeniaca* Willd. are dominant, and *Alhagi maurorum* subsp. *maurorum* and *Stipa hohenackeriana*, which were found to be among the dominant species according to our observations, are either absent or found in small numbers and with low overlap values. Furthermore, *Salvia cryptantha* and *Phlomis armeniaca* are the species belonging to the *Astragalo-Brometea tomentelli* class or its subunits (Quézel, 1973). Considering the soil texture, flora and syntaxonomy, it can easily be understand that the study conducted by Birand (1970) around Konya, Karapınar and Ereğli was carried out in clay-loamy steppe habitat, rather than sandy steppe habitat. Probably, Birand considered the areas containing dense sand in Örnektepe and its surroundings in Karapınar as "degraded steppe" and did not record the relevé, thinking that it would not reflect the truth.

The second study on xerophytic plant communities around Karapınar (Konya) was carried out by Bağcı et al. (1996). Compared to the previous two studies, it can be said that this study is more satisfactory in terms of syntaxonomy. Sixty three relevé recordings were made from xerophytic plant communities observed around Karapınar. As a result of the analysis of soil samples taken from the depths of 0-20 cm, 20-40 cm and 40-60 cm from the area, 5 xerophytic plant communities were identified growing on sandy and sandy-loam soils. Of these, the *Salsola ruthenicae-Alhagietum pseudalhagi* Bağcı, Tatlı & Kargıoğlu 1996, *Astragaletum lycio-microcephali* Bağcı, Tatlı & Kargıoğlu 1996 and the *Marrubio parviflori-Salvietum cryptanthae* Bağcı, Tatlı & Kargıoğlu 1996 prefer sandy soils with a sand ratio exceeding 68% and a clay ratio less than 18% (Bağcı et al., 1996; Bağcı and Dural, 1997). These data indicate that the sandy habitat dominated by the *Alhagi maurorum* subsp *maurorum* species in the vicinity of Karapınar was also determined by Bağcı et al. (1996).

Stipa hohenackeriana (in the study as *Stipa holosericea* Trin.) community was evaluated within the *Alhagi maurorum* subsp. *maurorum* community by Bağcı. Despite his detailed study, Bağcı et al. (1996) used the term "steppe" instead of "sandy steppe" for sandy habitats in his

study and attributed the identified communities to the *Astragalo-Brometea tomentelli* class and its subunits accordingly. However, when the table of the *Salsola ruthenicae-Alhagietum pseudalhagi* association is examined, it is clearly seen that the subunits of the *Astragalo-Brometea tomentelli* class are very weakly represented (Bağcı et al., 1996). It is also seen that Bağcı et al. (1996) evaluated the sandy steppe habitat in sandy-loam or clay-loam steppe, did not draw clear boundaries and therefore mixed the relevé record. According to the analysis, although the soil texture is "sandy", the existance of the species *Astragalus microcephalus* Willd., *A. lydius* Boiss., *A. lycius* Boiss., *Onobrychis armena* Boiss. & A. Huet, *Salvia cryptantha* and *Marrubium parviflorum* belonging to *Astragalo-Brometea tomentelli* class and its subunits, as dominant species or at higher rates in *Astragaletum lycio-microcephali* and *Marrubio parviflori-Salvietum cryptanthae* communities, also supports this confusion (Bağcı et al., 1996).

According accepted international standards and our observations, the areas around Karapınar (Konya) and its close environs with soil containing more than 68% sand and less than 18% clay, should be considered as "sandy steppe" (ISSS Working Group RB, 1998). On the other hand, a careful review of previous studies conducted in Karapınar and its close environ indicate that the authors neither not examined the sandy steppe habitat, regarding it as a "degraded habitat" nor handled as a different habitat type, evaluating it together with an onother steppe habitat, and made, if done, the syntaxonmy in accordance (Birand, 1970; Bağcı et al., 1996). In the vegetation studies conducted with the flora based Braun-Blanquet (1964) method, the relevé area was recommended as 50-100 m^2 for the steppe habitat and 1-10 m^2 for the dune and sandy steppe habitat (Whittaker, 1973). The reason why the relevé widths are determined differently for these two habitats is that the sandy steppe habitat is often found in small patches among other habitats. Sandy steppe habitat is found in small pieces in and around Karapınar. However, in previous studies, the of the relevé widths were taken as 36-100 m^2 (Bağcı et al., 1996). Due to higher relevé widths, species belonging to the sandy steppe habitat were recorded within the same sample of other steppe habitats in the environs.

The sandy steppe habitat of Karapınar had been ignored and evaluated within the other steppe type despite the studies carried out in the region. Here, we reveal that the habitat is different from other steppe habitats in the vicinity in terms of soil texture, flora and syntaxonomy. In Europe, plant communities belonging to the sandy steppe habitat on stationary dunes were attributed to *Koelerio-Corynephoretea canescentis* class, and were classified as "RLE1.1a Pannonian and Pontic sandy steppe" by taking under protection (Mucina et al.. 2016; EUNIS, 2022). On EUNIS website, the sandy steppes of Turkiye are classified in "E1A5 - Irano-Anatolian inland dunes" and their probable distribution is given. But necessary information about the general characteristics of the habitat, its floristic structure and syntaxa has not been given on the website, since necessary researches have not completely been conducted (EUNIS, 2022).

In order to overcome this deficiency and to classify the Turkish habitats properly, the syntaxonomy of the sandy steppes of Türkiye should urgently be analyzed.

Conflict of Interest

Authors declare that there is no conflict of interest.

Authors' Contributions

The authors confirm contribution to the manuscript as follows; study conception and design: Ergin Hamzaoğlu, Kuddisi Ertuğrul, analysis and interpretation of results, and draft manuscript preparation: Ergin Hamzaoğlu, data collection: Ergin Hamzaoğlu, Kuddisi Ertuğrul, Murat Koç.

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