

Conservation status, micro and macro morphology of the genus *Kyllinga* Rottb. (Cyperaceae) in Turkey

Türkiye'deki *Kyllinga* Rottb. (Cyperaceae) cinsinin koruma statüsü, mikro ve makro morfolojisi

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Abstract

The macro and micro morphology of *Kyllinga brevifolia*, an invasive species, was investigated in this study. *K. brevifolia* species has been thoroughly described, and population distribution data has been updated. Furthermore, the populations of *K. brevifolia* species in our country were assessed, and the IUCN threat category was identified. *Kyllinga brevifolia* pollen grains are spherical in shape and have a micro-echinate-perforated surface ornamentation. The fruit of *K. brevifolia* is obovoid and elliptical in shape, with a lenticular cross section, and the fruit surface ornamentation is reticulated-tuberculate. The most important aspect of combating invasive species is understanding the plant well enough to combat it. In our study, the characteristics of an invasive species, *K. brevifolia*, are described in detail. Furthermore, this study determined the pollen and fruit morphology of *K. brevifolia* for the first time.

Özet

Bu çalışmada, istilacı tür olarak bilinen *Kyllinga brevifolia* türünün makro ve mikro morfolojisi incelenmiştir. *Kyllinga brevifolia* türünün detaylı tür betimlemesi yapılmış ve popülasyonların yayılış bilgileri güncellenmiştir. Ayrıca, *K. brevifolia* türünün ülkemizdeki popülasyonları değerlendirilerek IUCN tehdit kategorisi de belirlenmiştir. *Kyllinga brevifolia*'nın polen taneleri, mikro-ekinat-delikli yüzey süslemeli, küresel şekillidir. *Kyllinga brevifolia* türünün meyvesi ise obovoid ve eliptik şekilli, enine kesitte mercekli bir şekle sahiptir ve meyve yüzeyleri süslemeleri ağıs-tüberküldür. İstilacı türleri ile mücadelenin en önemli unsuru mücadele edilecek olan bitkinin iyi tanınmasıdır. Çalışmamızda bu temeli göz önünde bulundurarak, istilacı bir tür olan *Kyllinga brevifolia* türünün özellikleri detaylı olarak verilmiştir. Ayrıca, *Kyllinga brevifolia* türünün polen ve meyve morfolojisi ilk kez bu araştırma ile belirlenmiştir.

INTRODUCTION

The genus *Kyllinga* Rottb. (Cyperaceae) comprises 40-45 species in warm temperate, tropical, and subtropical climates, especially Madagascar and tropical East Africa (Kükenthal 1936, Haines and Lye 1983, Tucker 1987, Bryson et al. 1997, Tucker et al. 2006, Paudel et al. 2012). The genus *Kyllinga*'s taxonomic taxonomy is extremely complex. It was considered *Kyllinga* to be a subgenus of *Cyperus* L. (Kükenthal 1936). However, *Kyllinga* has smaller spikelets in comparison with *Cyperus*. Moreover, *Kyllinga* can be distinguished from *Cyperus* by the combination of the following characteristics: a bicarpellate gynoeceum with a bifid style; bilaterally flattened achenes; an achenes angle that is adjacent to the rachilla axis; and spikelets that are basally articulated

(Bryson et al. 1997, Vrijdaghs et al. 2011). Because of these aspects, recent research has highlighted the fact that the genus *Kyllinga*, which was formerly thought to be a part of the genus *Cyperus*, should instead be considered to be a different genus that is a close relative of the genus *Cyperus*. (Bruhl 1995, Goetghebeur 1986, Koyama 1985, Tucker 1984, Tucker 1987, Bryson et al. 1997).

The only member of the genus *Kyllinga* to be found in Turkey is the *Kyllinga brevifolia* Rottb species. *Kyllinga brevifolia* has a wide distribution across warm and temperate zones (Tucker et al. 2006, Paudel et al. 2012). Byfield (2000) described the genus *Kyllinga* in the Flora of Turkey, but it was classified as *Cyperus brevifolius* (Rottb.) Haussk., a member of the genus *Cyperus*. According to

recent research (Güner 2012), *C. brevifolius* is considered as a synonym for *Kyllinga brevifolia* in the Turkish Flora.

Kyllinga species are extremely invasive, and controlling their spread is critical. *Kyllinga brevifolia* is a perennial plant that reproduces both vegetatively (by means of rhizomes and stolons) and asexually (by means of many seeds that are capable of developing into mature plants) (Sumaryono and Basuki, 1984, Lowe et al. 1999a, Rodiyati and Nakagoshi, 2003). Because this plant is a C4 species (Lin et al. 1993), it grows easily in areas where the temperature is between 30-35 degrees Fahrenheit (Black, 1973) and is likely hampered by low temperatures. Several investigations on the genus *Kyllinga* have been conducted. Bryson et al. (1997) studied *Kyllinga*, a neglected weed, across the continental United States. Somasundaram et al. investigated the hepatoprotective effect of *Kyllinga nemorales* (2010). Paudel et al. (2012) investigated the essential oil activity of *Kyllinga brevifolia*'s Nepalese leaf. Helliön-Ibarrola et al. (2012) investigated the anxiolytic and sedative properties of *Kyllinga brevifolia* in rats. Despite the fact that *K. brevifolia* is a dangerous weed for many crops and a highly invasive exotic species (Webb et al. 1981, Wagner et al. 1990), little is known about this plant. To effectively manage weeds, a plant must first be defined clearly and recognized. There is little known about the taxonomy, micro and macro morphology of the genus *K. brevifolia*. The purpose of this research is to look into the detailed data on *K. brevifolia*'s palynological, fruit, and morphological traits, as well as its distribution map and IUCN threat categories. The characteristics of an invasive species, *K. brevifolia*, are described in detail in this study.

MATERIAL and METHODS

The *Kyllinga brevifolia* was collected from the Coruh River in Artvin and placed in the Erciyes University Herbarium (ERCH, HS1412). The Flora of Turkey, Europa, Iran, Russian, and China, as well as samples from the ANK, ISTE, GAZI, HUB, G, and E herbaria's herbarium, were used to evaluate the collected samples. Morphological properties were measured using a Stereo Zoom microscope (Zeiss Stemi). The species' characteristics were determined by taking 50 measurements. For the palynological

examination, Wodehouse's technique was used (Wodehouse 1935). Light microscopy (LM) and scanning electron microscopy (SEM, Leo 440, Electron Microscopy Ltd., Cambridge, UK) were used to examine pollen grains collected from flowers. 30 pollen grains from each species were counted using light microscopy. The Punt et al. terminology was employed (Punt et al. 2007). The morphology of nuts was studied using binocular stereoscopic microscopy. Fruit dimensions were determined by measuring 30 nuts from species. The pollen grains and fruit were gold-coated and placed on stubs for SEM examination. At Erciyes University's Technology Research and Application Center, the samples were SEM analyzed.

RESULTS

Kyllinga brevifolia Rottb. Descr. Icon. Rar. Pl. 13 (1773), Fig. 1.

Type: "Syn. Pl. Glumac. 2: 23 (1854)"

Syn: *Cyperus bervifolius* (Rottb.) Hassk., Cat. Hort. Bot. Bogor. 24 (1844). *Kyllinga intermegia* var. *oligostachya* C.B.Clarke, J. Linn. Soc., Bot. 36: 224 (1903).



Figure 1. *Kyllinga brevifolia* habitus images (HS1412)

Description

Perennial herbs with plant lengths ranging from 3 to 45 cm. Rhizomes are long-creeping and thin, measuring 0.5-1 mm in width. The solitary stem is 0.5-1.5 mm in diameter, strongly trigonous, smooth, and green. Basal leaves are 1.5-3 mm broad, linear, smooth, and sharp, and are shorter than the stem. The sheaths of the leaves are brown or dark brown and up to 65 mm long. The inflorescence consists of a single thick head. Bracts are 3-4 in number and are shorter than the inflorescence. Spikelets are lanceolate and measure 2-6 x 0.8-1.5 mm. Rhachilla does not have wings. Glumes are 2-3.5 x 2-2.5 mm long, lanceolate, acuminate, and pale or yellowish with a mid-nerve green tint. Stamen has three digits. Stigma is represented by two numbers. The nut is lenticular, measuring 1.460.07 x 0.850.06 mm and being yellowish-brown in hue.

Phenology

From June to October, flowers and fruits are available.

Habitat

Wet grassland, riverbanks, and damp areas at elevations ranging from 5 to 850 meters.

Conservation Status

Kyllinga brevifolia is only found in a few locations in Turkey's Artvin, Rize, Ordu, Samsun, and Giresun provinces (Fig. 2). *Kyllinga brevifolia* was classified as Least Concern (LC) at both the international and national levels due to the fact that it grows in Europe, China, East Asia, and North America, as well as other parts of the world (IUCN 2020).

Examined Specimens

Artvin: Hopa, Kemalpaşa village, 5 m, 17 viii 1995, A.J. Byfield 1951 & S. Atay (ISTE, 69303!); Artvin: Karsıkoy mevki, Coruh riversides, 41°27'265"N, 41°43'262"E, 101 m, 29 viii 2014, HS1412, ERCH. Giresun: Espiye'nin batısı, 5 m, A.J. Byfield 1337 & S. Atay. Ordu: Melet river mouth, 5 m, A.J. Byfield 1345 ve S. Atay. Samsun: Salıpazarı, Gökceli, Terme riversides, 50 m, 06 x 2003, B. Şahin 1687 (GAZI!). Rize: Pazar, İyidere river mouth, 100 – 200 m, 16 viii 1995, A.J. Byfield 1863 & S. Atay (ISTE 69215!). Rize: Ardeşen, Fırtına rivermouth, 19 viii 1995, A.J. Byfield 1928 & S. Atay (ISTE 69280!). Samsun: Çarşamba, Yeşilirmak river mouth, 10 m, 13 x 1994, A.J. Byfield 1364 (ISTE 67605!). Samsun: Akçay river mouth, 2 m, 12 x 1994, A.J. Byfield 1354 (ISTE 67595!).

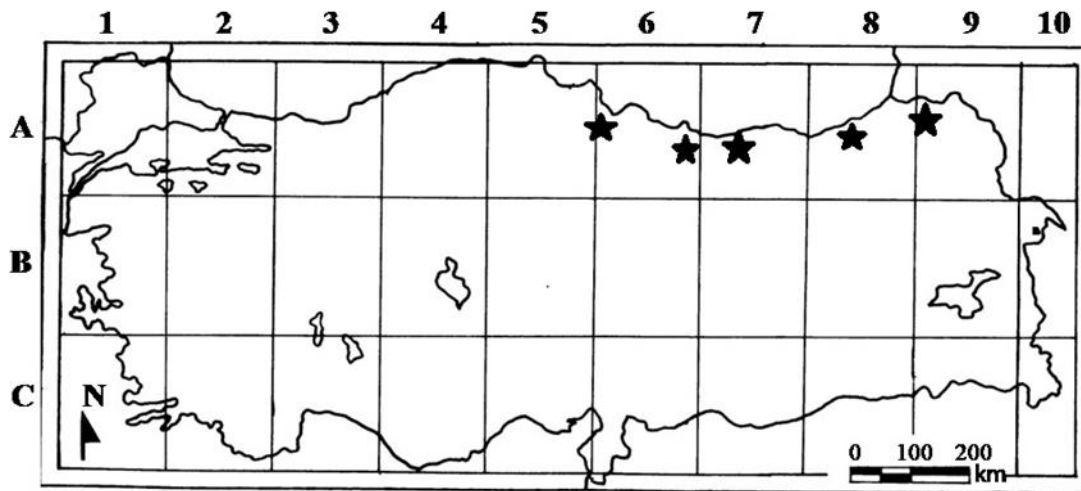


Figure 2. Distribution of *Kyllinga brevifolia* (Sapci 2017)

Fruit Morphology

Kyllinga brevifolia fruit morphologies include obovoid and elliptical shapes (Fig. 3). The fruits are lenticular in cross-section and contain reticulate-tuberculate surface ornamentation. *K. brevifolia* taxa's nuts were yellowish-brown in colour. According to our morphometric data, the shortest nut of *K. brevifolia* is around 1.31 mm long, while the longest is approximately 1.58 mm long. *K. brevifolia* had the broadest fruit, measuring approximately 0.97 mm in width. *K. brevifolia* also has the thinnest 0.72 mm. In *K. brevifolia*, the length/width ratio was found to be 1.72.

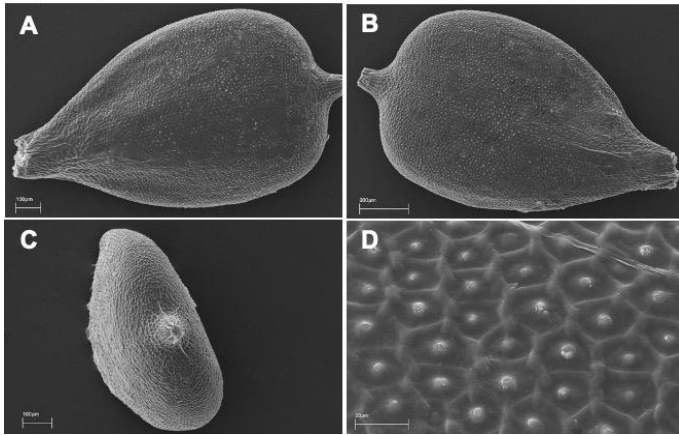


Figure 3. Fruits of *Kyllinga brevifolia* (Scanning Electron Microscope photographs).

Pollen Morphology

Kyllinga brevifolia pollen is radially symmetric, heteropolar, and four aperturate with one distal ulceroid aperture (Fig.4).

Pollen grains are subspheroidal (P/E: 1.26) in shape. The polar diameter (P) is 21.592.08 m (18.47-25.78) m, and the equatorial diameter (E) is 17.322.09 m (14.3-21.44) m. Pollen has microechinate-perforated surface ornamentations.

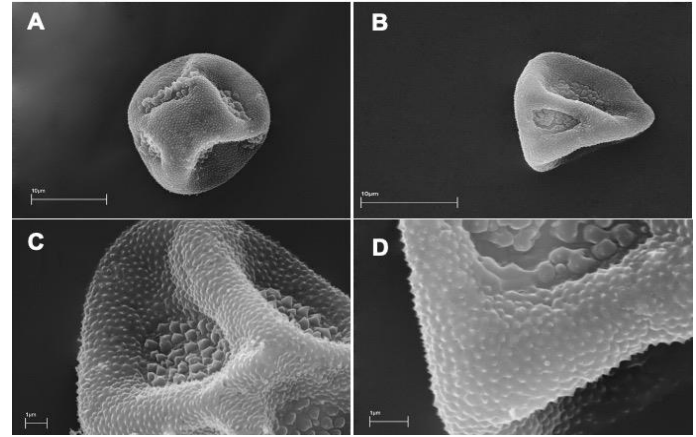


Figure 4. Pollen grains of *K. brevifolia* (Scanning Electron Microscope photographs)

DISCUSSION and CONCLUSION

Kyllinga brevifolia, like many other perennial plants, displays a substantial vegetative reproduction effort. The most important factor for *K. brevifolia* to grow in temperate climates is adequate heat (Rodiyati and Nakagoshi 2003). They emerge in late spring/early summer when soil temperatures rise, grow throughout the summer, and die with the first frost in the fall, like many other warm-season perennial weeds. Because *K. brevifolia* are perennials that grow from underground rhizomes and/or tubers, they can be difficult to control. *Kyllinga brevifolia* could be a sign that the soil is always too wet, which should always be addressed as part of a larger treatment plan. Knowing the characteristics of the invasive species is one of the most important things to know before fighting it. specially, herbicides that are commonly used to control *Kyllinga* species, on the other hand, are not completely effective against them. For example, *Kyllinga brevifolia* is difficult to remove by hand due to the underground rhizomes and dense mat that forms. Especially, herbicides that are commonly used to control *Kyllinga* species, on the other hand, are not completely effective against them. It is critical to conduct extensive research on these species in order to better understand them. Understanding the geographic distribution of species is critical for avoiding harmful consequences in the present and future.

The number and type of apertures, as well as the lengths of the polar and equatorial axes, are distinguishing characteristics of Cyperaceae pollen (P and E). Pollen

shape, exine thickness, and sculpture are all important characteristics (Wichelen et al. 1999; Moar and Wilmshurst 2003, Willard et al. 2004). Unfortunately, the distributions of the features and species studied are arranged in such a way that it is impossible to determine species or draw conclusions about the relationship of taxa within the genus based on pollen grain features. Many researchers have attempted to classify Cyperaceae pollen types. Apertures are found in Cyperaceae pollen grains with a single distal ulceroid, according to Shah (1962). Cyperaceae pollens were defined by Wodehouse (1965) as a single, weakly distinguishing pollen with irregularly shaped pores. According to Koyama (1961), most Cyperaceae (including the genus *Carex*) have apple-shaped pollen. Moore et al. (1991) described Cyperaceae pollen grains as pear-shaped or roughly spherical in shape. Species from the genus *Kyllinga* were not studied in any of the studies, but closely related genera such as *Cyperus* were. According to study results, *Kyllinga brevifolia* pollen is almost pear-shaped, and has four aperturate with one distal ulceroid aperture.

There have been a few studies on the seed morphology of the researcher Cyperaceae species. However, none of the *Kyllinga* species have been studied. In the Cyperaceae family, the fruits of sedges are most commonly achenes (nutlets), but in a few genera. The fruit of Cyperaceae usually triangular, lenticular or trigonous in cross-section with three fimbriate perianth scales opposite the flat sides of the nutlet. Also, fruits are small single-seeded nutlet.

Kyllinga brevifolia fruit is lenticular in cross-section, single seeded, and reticulate-tuberculate ornamentation.

In this study, the micro and macro morphological characteristics of the species were examined in depth. The primary objective of our study was to understand more about this invasive plant in order to aid in weed control.

In addition, some authors speculate that the *Kyllinga* may have split off from *Cyperus* (Bryson et al. 1997, Vrijdaghs et al. 2011). Similarly, our findings suggest that *Kyllinga*, with its reduced spikelets, bifid style, and lenticular nuts, is not a *Cyperus* subgenus. As a result, the genus *Kyllinga*,

whose taxonomic status is debatable, should be considered distinct from the others. The uncertainty surrounding the classification of this species was systematically further clarified by this study.

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