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The moss flora of Koramaz Valley in the Central Anatolia (Kayseri)

Harun ÇULHA¹ , Tülay EZER² *

¹Niğde Ömer Halisdemir University, Faculty of Science, Department of Biology, Niğde, TÜRKİYE
²Niğde Ömer Halisdemir University, Faculty of Architecture, Department of Landscape Architecture, Niğde, TÜRKİYE

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Abstract

In this study, the moss flora of Koramaz Valley in Central Anatolia (Kayseri) was investigated. As a result of the identification of 611 moss specimens collected from the valley, a total of 93 taxa belonging to 14 families and 35 genera were determined. Among them, *Tortula lingulata* is recorded the second time in Türkiye, while 6 taxa are new for the B8 grid square. While Pottiaceae was the richest family in the study area with 35 taxa, Grimmiaceae ranked second with 12 taxa, and Brachytheciaceae ranked third with 11 taxa. The largest genera in the Koramaz Valley were *Syntrichia* (11 taxa) and *Didymodon* (10 taxa). *Amblystegium serpens*, *Syntrichia virescens*, and *Tortula brevissima* are the most common species in the valley.

Keywords: Central Anatolia, Mosses, Valley, Türkiye.

Orta Anadolu'daki Koramaz Vadisi'nin (Kayseri) karayosunu florası

Öz

Bu çalışmada, Orta Anadolu'daki (Kayseri) Koramaz Vadisi'nin karayosunu florası araştırılmıştır. Vadiden toplanan 611 karayosunu örneğinin teşhis çalışmaları sonucunda 14 familya ve 35 cinse ait toplam 93 takson tespit edilmiştir. Bunlar arasında *Tortula lingulata* Türkiye'de ikinci kez kaydedilirken, 6 takson B8 grid karesi için yenidir. Pottiaceae 35 takson ile çalışma alanındaki en zengin familya olurken, Grimmiaceae 12 takson ile ikinci ve Brachytheciaceae 11 takson ile üçüncü sırada yer almıştır. Koramaz Vadisi'ndeki en büyük cinsler *Syntrichia* (11 takson) ve *Didymodon* (10 takson) olmuştur. *Amblystegium serpens*, *Syntrichia virescens* ve *Tortula brevissima* vadideki en yaygın türlerdir.

Anahtar kelimeler: Orta Anadolu, Karayosunları, Vadi, Türkiye.

* Corresponding author: tuezer@gmail.com; tezer@ohu.edu.tr

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1. Introduction

The bryophytes are land plants forming the second group of the plant kingdom with about 15.000-25.000 species. Within the sub-kingdom Bryobiotina, it is divided into three division as Anthocerotophyta (hornworts), Marchantiophyta (liverworts) and Bryophyta (mosses). These plants, which are an integral part of ecosystems on earth, can grow on many substrates such as soil, rock surfaces, living or dead logs and tree trunks (Goffinet and Shaw, 2009; Glime, 2017). Due to their primitive structures, ecological factors such as shade, moisture and temperature directly affect the survival of these plants (Bahuguna et al., 2013).

Türkiye is located at the intersection of three different phytogeographic regions (Mediterranean, Euro-Siberian and Irano-Turanian) and harbours elements of all three phytogeographic regions. This situation has brought phytodiversity. Due to its geographical location, Türkiye has also served as a natural bridge between Asia and Europe for many species (Aktürk and Güney, 2021).

The bryo-floristic studies carried out so far have shown that Türkiye is very rich in terms of bryo-diversity, although there are many areas that have not yet been studied. With the floristic studies carried out in recent years, the total number of taxa of bryophytes in Türkiye has increased to ± 1289 (± 1056 mosses, ± 229 liverworts and ± 4 hornworts) (Özenoğlu and Kırmacı, 2022; Erata et al., 2023; Ezer et al., 2024; Batan et al., 2024; Ezer et al., 2025).

Further floristic studies are expected to reveal even greater bryological diversity in Türkiye. To date, only the macrofungi of Koramaz Valley, which was added to UNESCO's Tentative List of Cultural Heritage Sites on 14 April 2020, have been studied (Allı, 2021; URL1) No bryo-floristic study has been carried out on the mosses in the valley. Therefore, the present study aims to reveal the moss flora of Koramaz Valley in the Central Anatolia and to contribute to the Turkish bryoflora.

2. Material and Methods

2.1. Study area

The Koramaz Valley is located within the borders of Melikgazi district of Kayseri in Central Anatolia and the longest valley after Ihlara Valley in the Central Anatolia Region, was formed as a result of a 12 km long earthquake fracture curving from east to west (Yazlık, 2019). The altitude at the westernmost part of the valley is 1165 meters, and at the easternmost end it is 1500 meters. The Koramaz Valley is located within the Irano-

Turanian Phytogeographic Region and is within the B8 grid-square in the grid system adopted by Henderson (1961) for Turkish bryophytes (Fig. 1).

Large areas of Kayseri are covered by volcanic units of the Neogene and in the east of the area the Neogene Pliocene units consist of limestone, clay and marl. The most common soil type in Koramaz Valley is brown soil. Colivial soils are found around Subaşı and Küçük Bürüngüz villages, while red brown soils are observed in the northeast of the area (Uzunhisarcıklı and Vural, 2004).

According to the results of 37 years of observations of Kayseri meteorological station, the average annual precipitation is 390.5 mm and the annual average temperature is 10.7°C. The study area has a cold semi-arid Mediterranean climate (Akman, 1999).

Koramaz Valley has a milder climate than its surroundings thanks to the Koramaz Stream that flows through it. For this reason, tree species such as *Salix alba* L., *Platanus orientalis* L., *Elaeagnus angustifolia* L., *Crataegus monogyna* Jacq., *Juglans regia* L. and *Populus thevestina* Dode as well as shrub forms such as *Rosa canina* L., *Rubus sanctus* Schreb. and especially *Viburnum opulus* L. are dominant on the valley floor and slopes. Herbaceous species include *Ranunculus repens* L., *Mentha longifolia* (L.) L. *Trifolium repens* L. In the areas outside the valley, steppe vegetation is dominant and *Adonis aestivalis* L., *Astragalus lycius* Boiss., *Astragalus densifolius* Lam., *Onobrychis armena* Boiss., *Carduus nutans* L. and *Verbascum cheiranthifolium* var. *asperulum* (Boiss.) Murb. are the main species.

2.2. Data source

The bryophyte specimens were collected from various substrates during the land studies between October 2022-September 2023 (Table 1). The collected specimens from the Koramaz Valley were identified using various flora, revision and monograph studies (Zander, 1993; Greven, 2003; Munoz, 1999; Cortini Pedrotti, 2001, 2006; Smith, 2004; Guerra et al., 2006; Guerra and Cros, 2007; Kürschner and Frey, 2020).

The voucher specimens are stored in the Herbarium of Niğde Ömer Halisdemir University and the nomenclatural arrangement in the floristic list follows Hodgetts et al. (2020). New records for B8 are indicated with an asterisk (*) and second record for Türkiye is two asterisks (**) in the floristic list (Table 2).

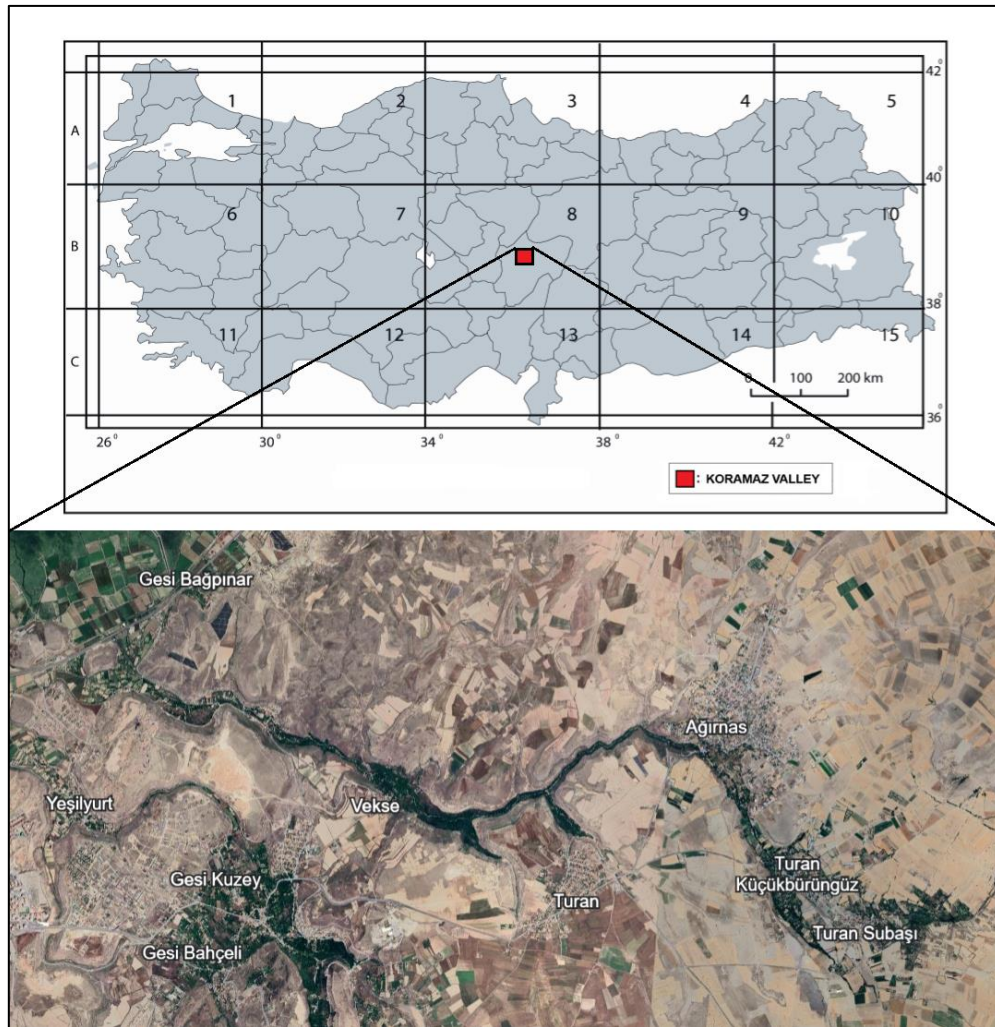


Figure 1. Henderson's (1961) grid-system and location of the Koramaz Valley (Changed from Google Earth).



Figure 2. Vegetation types in the Koramaz Valley (Photos: T. Ezer).

Table 1. Locality details (L.N.: locality numbers)

L.N.	Locality-GPS coordinate-Date	Altitude (m)
1	Ağırnas Village, Mosque garden, 38°48'54"N / 35°43'8"E, 14-15.10.2022	1318
2	Hacetpınarı place, 38°48'23"N / 35°43'22"E, 14.10.2022, 19.11.2022, 12.05.2023, 20-22.07.2023, 14-16.09.2023	1323
3	Ağırnas Wedge Gardens, 38°48'44"N / 35°43'5"E, 14-15.10.2022, 19.11.2022	1289
4	Ağırnas Village, 38°48'47"N / 35°43'00"E, 14.10.2022, 15.12.2022, 02.02.2023	1309
5	Ağırnas Underground City, 38°48'49"N / 35°42'57"E, 14-16.10.2022, 19.11.2022	1304
6	Ağırnas Village, Bezirhane, 38°48'58"N / 35°43'11"E, 14.10.2022	1324
7	Ağırnas Village, Agios Prokopios Church, 38°49'2"N / 35°43'12"E, 14-15.10.2022	1343
8	Ağırnas Village, 38°48'41"N / 35°43'6"E, 14-15.10.2022, 19.11.2022	1311
9	Ağırnas Village, side of Koramaz Stream, 38°48'48"N / 35°42'57"E, 15-16.10.2022	1334
10	Ağırnas Village, Cumhuriyet Square, 38°49'2"N / 35°43'7"E, 16.10.2022, 19.11.2022	1322
11	Küçük Brüngüz Village, side of Koramaz Stream, 38°48'8"N / 35°43'46"E, 15.10.2022, 19.11.2022	1327
12	Küçük Brüngüz Village, Wedge Gardens, 38°48'8"N / 35°43'46"E, 19.11.2022	1317
13	Küçük Brüngüz Village, within the underground city, 38°48'46"N / 35°42'58"E, 20.11.2022	1310
14	Vekse Village road, 38°48'12"N / 35°40'24"E, 20.11.2022, 15.12.2022	1224
15	Vekse Village, 38°48'17"N / 35°40'23"E, 20.11.2022, 12.12.2022, 02.02.2022, 10.05.2023	1191
16	Turan Village, 38°48'11"N / 35°42'3"E, 20.11.2022, 12.12.2022, 10.05.2023	1278
17	Mançur place, Wedge Gardens, 38°48'12"N / 35°41'4"E, 20.11.2022	1220
18	Mançur place, side of Koramaz Stream, 38°48'28"N / 35°40'47"E, 12-13.12.2022	1212
19	Mançur place, 38°48'16"N / 35°40'37"E, 12-15.12.2022, 11.05.2022, 16.09.2023	1254
20	Bağpınar Village, 38°48'39"N / 35°39'18"E, 14-15.12.2022	1150
21	Between the Vekse and Bağpınar Village, 38°48'35"N / 35°39'51"E, 15.12.2022	1161
22	Side of Koramaz Stream, between the Vekse and Bağpınar Village, 38°48'34"N / 35°39'55"E, 15.12.2022	1141
23	Küçük Brüngüz Village, 38°47'38"N / 35°43'59"E, 15.12.2022, 10.05.2023, 21-22.07.2023, 15.09.2023	1359
24	Between the Ağırnas and Turan Village, 38°48'53"N / 35°42'18"E, 03-04.02.2023, 14-15.09.2023	1284
25	Between the Ağırnas and Turan Village, Wedge Gardens, 38°48'50"N / 35°42'42"E, 04-05.02.2023	1280
26	Between the Ağırnas and Turan Village, side of Koramaz Stream, 38°48'49"N / 35°42'48"E, 05.02.2023	1308
27	Ağırnas entrance gate, 38°48'50"N / 35°42'55"E, 05.02.2023, 20-22.07.2023, 16.09.2023	1308
28	Slopes of Koramaz Vallacy, 38°48'2"N / 35°45'3"E, 05.02.2023	1404

3. Results and Discussions

As a result of the identification of 611 moss specimens collected from the Koramaz Valley, 35 genera belonging to 14 families and a total of 93 taxa were determined.

Among them, six species are new records for the B8 grid-square, and one species is second record for Türkiye (Table 2).

Table 2. Bryofloristic list. L.N.: locality number, t: tree, s: soil, r: rock, rs: thin layer of soil covering rocks.

Families	L.N.	Taxa	Substrates			
			t	s	r	rs
BRYOPHYTA (MOSES)						
Encalyptaceae	19,23	<i>*Encalypta streptocarpa</i> Hedw.		+	+	+
	16,23	<i>E. vulgaris</i> Hedw.		+	+	+
Funariaceae	1,2,4,5,10	<i>Funaria hygrometrica</i> Hedw.		+	+	+
Fissidentaceae	15	<i>Fissidens exilis</i> Hedw.			+	
Pottiaceae	2,23,27	<i>Crossidium squamiferum</i> (Viv.) Jur.		+	+	+
	3,5,8,15,16,24,27	<i>Didymodon acutus</i> (Brid.) K.Saito		+	+	+
	5	<i>*D. bistratosus</i> Hébr. & R.B.Pierrot				+
	4,5,8,14,15,16	<i>D. cordatus</i> Jur.		+	+	+
	15,24,27	<i>D. fallax</i> (Hedw.) R.H.Zander		+	+	
	16,23	<i>D. insulanus</i> (De Not.) M.O.Hill			+	
	18,19	<i>D. luridus</i> Hornsch.			+	
	2,3,5,15,16,19,25	<i>D. nicholsonii</i> Culm.		+	+	+
	3,9,16	<i>D. rigidulus</i> Hedw.		+	+	
	2,5,11,20,24,25	<i>D. tophaceus</i> (Brid.) Lisa			+	+

	2,3,4,5,10,11,15,21,24,25,27	<i>D. vinealis</i> (Brid.) R.H.Zander	+	+	+	+
	17	<i>Microbryum davallianum</i> (Sm.) R.H.Zander.			+	
	19,24,28	<i>Pseudocrossidium revolutum</i> (Brid.) R.H. Zander		+		+
	2,23,27,28	<i>Pterygoneurum ovatum</i> (Hedw.) Dixon		+		+
	15	<i>Syntrichia caninervis</i> Mitt. var. <i>caninervis</i>			+	
	23	<i>S. caninervis</i> var. <i>gypsophila</i> (J.J.Arnran ex G.Roth) Ochyra			+	
	23	<i>S. caninervis</i> var. <i>pseudodesertorum</i> (Vondracek) M.T.Gallego			+	
	23,24	<i>S. handelii</i> (Schiffn.) S.Agnew & Vondr.		+	+	
	3,26	* <i>S. laevipila</i> Brid.	+			
	20,23	<i>S. latifolia</i> (Bruch ex Hartm.) Huebener	+		+	
	23	<i>S. montana</i> Nees			+	+
	15,17,20	<i>S. norvegica</i> F.Weber		+	+	
	2,15,24	<i>S. princeps</i> (De Not.) Mitt.		+	+	
	2,15,19,23,24,27	<i>S. ruralis</i> (Hedw.) F.Weber & D.Mohr		+	+	+
	4,5,7,8,10,15,16,18,19,21,22,23,24	<i>S. virescens</i> (De Not.) Ochyra	+	+	+	+
	4,16,19,20	<i>Tortula atrovirens</i> (Sm.) Lindb.		+	+	+
	1,2,3,4,5,15,16,17,18,19,20,21,22,23,24,25,27,28	<i>T. brevissima</i> Schiffn.		+	+	+
	2,5,16,19,23,24,27	<i>T. inermis</i> (Brid.) Mont.		+	+	+
	20	** <i>T. lingulata</i> Lindb.			+	
	1,4,14,19	<i>T. muralis</i> Hedw.			+	+
	2,4,16,18,24,26,27,28	<i>T. subulata</i> Hedw.	+	+	+	+
	20	* <i>Eucladium verticillatum</i> (With.) Bruch & Schimp.			+	
	24	<i>Gymnostomum aeruginosum</i> Sm.			+	
	15,19,20	<i>G. calcareum</i> Nees & Hornsch.			+	
	28	<i>G. viridulum</i> Brid.				+
Grimmiaceae	8,19,23	<i>Grimmia anodon</i> Bruch & Schimp.			+	
	24	<i>G. capillata</i> De Not.			+	
	15	<i>G. funalis</i> (Schwägr.) Bruch & Schimp.			+	
	2,3,16,19,24	<i>G. laevigata</i> (Brid.) Brid.			+	
	2,5,15	<i>G. orbicularis</i> Bruch ex Wilson			+	
	2,15,19,24	<i>G. ovalis</i> (Hedw.) Lindb.			+	
	4,15,23	<i>G. plagiopoda</i> Hedw.			+	
	2,4,5,15,18,24,25	<i>G. pulvinata</i> (Hedw.) Sm.			+	+
	2,8	<i>G. reflexidens</i> Müll.Hal.			+	
	23	<i>Schistidium atrofusum</i> (Schimp.) Limpr.			+	
Bryaceae	23	<i>S. flaccidum</i> (De Not.) Ochyra			+	
	2,28	<i>S. platyphyllum</i> (Mitt.) H.Perss.			+	
	1,2,4,7,15,18,19,20,23,24	<i>Bryum argenteum</i> Hedw.		+	+	+
	2,16,19,23,24,25	<i>B. dichotomum</i> Hedw.			+	+
	18	<i>Imbriobryum mildeanum</i> (Jur.) J.R.Spence		+		
	2,24	<i>Ptychostomum compactum</i> Hornsch.		+	+	
	1,2,7,15,16,19,23	<i>P. imbricatum</i> (Müll.Hal.) Holyoak & N.Pedersen		+	+	+
Mniaceae	1,2,5,6,7,15,16,18,19,23,24,27,28	<i>P. inclinatum</i> (Sw. ex Brid.) J.R.Spence		+	+	+
	16	<i>P. moravicum</i> (Podp.) Ros & Mazimpaka	+			
	15	<i>P. pallens</i> (Sw. ex anon.) J.R.Spence			+	
Orthotrichaceae	14,15	* <i>Pohlia melanodon</i> (Brid.) A.J.Shaw				+
	19	<i>Lewinskya rupestris</i> (Schleich. ex Schwägr.) F.Lara, Garilleti & Goffinet	+		+	
	14,24,27	<i>Orthotrichum anomalum</i> Hedw.			+	+
	2,19,27	<i>O. cupulatum</i> Brid.	+		+	
	24	<i>O. bistratosum</i> (Schiffn.) Guerra			+	
	18,19,24	<i>O. diaphanum</i> Brid.	+			
	4,17,19,27	<i>O. pallens</i> Bruch ex Brid.	+			
	19	<i>O. pumilum</i> Sw. ex anon.	+			
	19,24,27	<i>O. tenellum</i> Bruch ex Brid.	+			
	23	<i>O. urnigerum</i> Myrin	+			

	27	<i>Pulviger a lyellii</i> (Hook. & Taylor) Plášek, Sawicki & Ochyra	+			
Amblystegiaceae	19	<i>Cratoneuron filicinum</i> (Hedw.) Spruce			+	
	4,5,9,15,16,18,19,20,21,23,24,27,28,	<i>Amblystegium serpens</i> (Hedw.) Schimp.	+	+	+	+
	24	<i>Campyliadelphus chrysophyllus</i> (Brid.) R.S.Chopra			+	+
	24	* <i>Campylophyllopsis calcarea</i> (Crundw. & Nyholm) Ochyra			+	
	19,24	<i>Hygroamblystegium fluviatile</i> (Hedw.) Loeske		+	+	
	24,27	<i>H. tenax</i> (Hedw.) Jenn.			+	
	4,24	<i>H. varium</i> (Hedw.) Monk.			+	+
Pseudoleskeaceae	2,24,27	<i>Pseudoleskeella catenulata</i> (Brid. ex Schrad.) Kindb.	+	+	+	
	1,2,27	<i>P. tectorum</i> (Funck ex Brid.) Kindb. ex Broth.			+	+
Brachytheciaceae	15	<i>Rhynchostegiella curviseta</i> (Brid.) Limpr.			+	+
	15	<i>R. litorea</i> (De Not.) Limpr.			+	
	20	<i>Scleropodium cespitans</i> (Wilson ex Mull.Hal.) L.F.Koch			+	
	24	<i>Brachythecium capillaceum</i> (F.Weber & D.Mohr) Giacom.			+	
	24	<i>B. mildeanum</i> (Schimp.) Schimp.			+	+
	24,27	<i>B. rutabulum</i> (Hedw.) Schimp.		+		
	3	<i>B. salebrosum</i> (Hoffm. ex F.Weber & D.Mohr) Schimp	+			
	2,3,15,25,27	<i>Homalothecium lutescens</i> (Hedw.) H. Rob.	+		+	+
	2,4,5,15,16,19,23,24,25,27,28,	<i>H. philippeanum</i> (Spruce) Schimp.	+		+	+
	4,15,19,23,24,27	<i>H. sericeum</i> (Hedw.) Schimp.	+		+	+
	23,24	<i>Oxyrrhynchium hians</i> (Hedw.) Loeske			+	+
Hypnaceae	16	<i>Hypnum cupressiforme</i> Hedw.			+	
Leucodontaceae	24,27	<i>Leucodon sciuroides</i> (Hedw.) Schwägr.	+		+	
Lembophyllaceae	27	<i>Isothecium alopecuroides</i> (Lam. ex Dubois) Isov.			+	

The most species-rich families of bryoflora in the Koramaz Valley were Pottiaceae with 35 taxa, Grimmiaceae with 12 taxa and Bryaceae with 11 taxa. These three families constitute 62.3% of all families (Fig. 3). The Pottiaceae, the dominant family of areas under the influence of the Mediterranean climate, is a large group consist of mostly drought-resistant species. Members of the Pottiaceae are particularly strongly adapted to the harsh conditions of the characteristic Mediterranean climate with a long dry period (Ros et al., 2013; Keskin and Ezer, 2024). Considering that the Koramaz Valley has a cold semi-arid Mediterranean climate, the dominance of Pottiaceae is an expected result. Another xerophytic family, the Grimmiaceae, is co-dominant in the valley with twelve species. The acrocarpous members of the family were widespread especially on the rocky slopes in the south of the valley. The pleurocarpous moss family Brachytheciaceae is relatively common in the Koramaz Valley with the eleven species. This is due to the presence of mesic habitats

on the valley floor, which have more humid microclimatic conditions than the slopes.

The most commonly encountered genera in the study area were *Syntrichia* Brid. and *Didymodon* Hedw. (Table 2). The *Syntrichia* is one of the most numerous and complex genera of Pottiaceae, a family of mosses characterised by harsh environmental conditions and has a worldwide distribution in almost all terrestrial ecosystems (Jauregui-Lazo et al. 2023). Considering the harsh living conditions of the Central Anatolian steppes where the Koramaz Valley is located, it is usual for this xerophytic acrocarpous genus to be dominant. Another member of the family, the cosmopolitan *Didymodon*, occurs in temperate, mountainous and drought regions on the earth (Kou et al., 2020). The species diversity of the members of these two genera in the study area has led to the dominance of Pottiaceae.

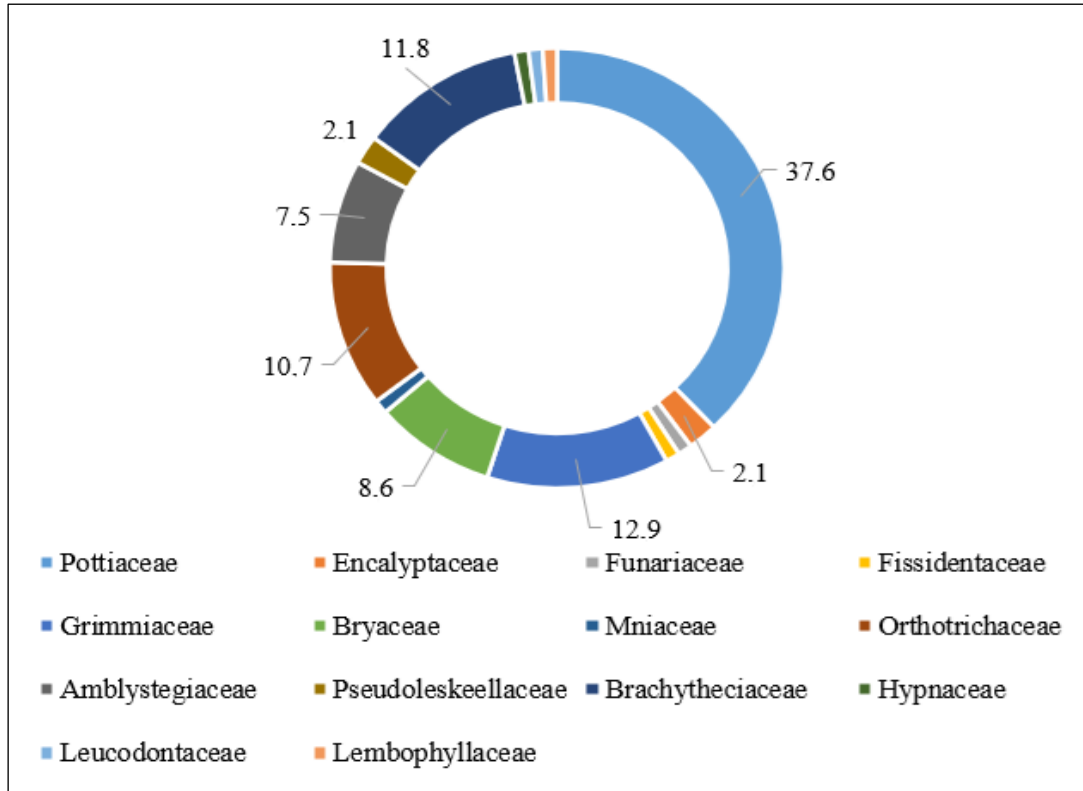


Figure 3. Percentage distribution of families.

In Koramaz Valley, 75.3% of the taxa identified are acrocarpous mosses. The predominance of acrocarpous mosses is not surprising considering the general vegetation of the region, which is steppe. Pleurocarpous mosses, which are more sensitive to drought, were represented with 24.7%. Pleurocarpous mosses were distributed on relatively moist rocks and moist soils at the floors of the Koramaz Valley.

As a result of this study, *Tortula lingulata* was recorded from Türkiye for the second time and presented as a full text paper at the EurosianBiochem 2023 conference (Çulha and Ezer, 2023). *Encalypta streptocarpa*, *Didymodon bistratosus*, *Syntrichia laevipila*, *Eucladium verticillatum*, *Pohlia melanodon* and *Campylophyllopsis calcarea* were determined as new records for B8 grid-square. These findings underline the floristic significance of the Koramaz Valley and highlight the need for continued exploration in other understudied regions of Central Anatolia. The present paper has revealed the moss flora of Koramaz Valley and will contribute to the bryophyte flora of Türkiye.

Declaration

Author contributions: Idea/Concept: TE; Conceptualization and design: TE; Auditing consulting: TE; References: TE, HÇ; Materials: TE,

HÇ; Data collection and/or processing: TE, HÇ; Analysis and/or interpretation: TE, HÇ; Literature search: HÇ, TE; Writing phase: TE, HÇ; Critical review: TE.

Conflict of interest: The authors have no competing interests to declare in relation to the content of this article.

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Ethical approval: This research does not involve human or animal subjects and therefore does not require ethical approval.

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