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Current Checklist and Distribution of Liverworts (Marchantiophyta) and Hornworts (Anthocerotophyta) in Türkiye

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Abstract

Through a comprehensive review of the literature, a checklist comprising 80 genera and 219 taxa belonging to 45 families has been compiled. Additionally, their distributions have been presented in a tabular format according to Henderson's (1961) quadrat system. For the first time, a list has been compiled based on up-to-date phylogenetic relationships, replacing the alphabetical arrangement adopted in earlier reference works. Ambiguous station records and species synonymies (covering 200 names) are discussed in 89 separate commentary notes presented under the table. A review of 128 bryophyte publications from 2009 to 2025 was conducted, resulting in the selection of 88 publications for inclusion in the updated reference list of Turkish liverworts and hornworts, presented following the study. After a 16-year hiatus, this investigation documented 45 new species records and 285 new grid records for Türkiye. Thirteen of the new grid records were provided by the present study. The families with the highest number of taxa are Ricciaceae, represented by 28 species, and Scapaniaceae, represented by 24 species. The aim of this study is to present the current status of Türkiye's liverwort & hornwort flora, evaluate the distribution of existing species, document new species and grid records, and contribute to future floristic research.

Keywords: Türkiye, Marchantiophyta, Liverwort, Hornwort, Checklist, Flora, Distribution

Türkiye'deki Ciğerotları (Marchantiophyta) ve Boynuzotlarının (Anthocerotophyta) Mevcut Kontrol Listesi ve Dağılımı

Öz

Literatürdeki tüm kaynakların taranması ile 45 familyaya ait 80 cins buna bağlı 219 taksonun kontrol listesi yapılmıştır. Ek olarak Henderson (1961) kareleme sistemine göre dağılımları tablo şeklinde sunulmuştur. Önceki çalışmalarda başvuru listesinde kullanılan alfabetik sıralama yerine ilk kez güncel filogeniye göre sıralanan yeni bir liste hazırlanmıştır. Belirsiz istasyon kayıtları ve türlerin sinonimlik durumları (200 isim işlem görmüştür) tablo altında verilen 89 ayrı vurgu metninde tartışılmıştır. 2009-2025 yılları arasında sunulan 128 briyofit yayını incelenmiş ve 88 tanesi güncel Türkiye Ciğerotu ve Boynuzotu referans listesi olarak sona sunulmuştur. 16 yıl aradan sonra bu araştırmayla Türkiye için 45 yeni tür kaydı ve 280 yeni kare kaydı tespit edilmiştir. Yeni kare kayıtlarının 13'ü bu çalışmada tarafımızdan verilmiştir. En çok takson içeren familyalar Ricciaceae 28 tür, Scapaniaceae 24 tür ile temsil edilmektedir. Bu çalışmanın amacı Türkiye ciğerotu ve boynuzotu florasının güncel durumunu ortaya koymak, mevcut türlerin dağılımını değerlendirmek, yeni tür ve kare kayıtlarını belgelemek ve gelecekte yapılacak floristik çalışmalara katkı sunmaktır.

Anahtar kelimeler: Türkiye, Marchantiophyta, Ciğerotu, Boynuzotu, Checklist, Flora, Dağılım

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1. Introduction

The division Marchantiophyta (liverworts), which is classified within terrestrial plants, is represented by approximately 5,000 taxa worldwide (Söderström et al. 2016). The general taxonomic classification of the division is based on the structural forms of the plants, which also play a role in determining the classes. These forms are categorized into three types: thalloid, leafy, and intermediate. Among them, the leafy form contains the highest number of species. Another division within terrestrial plants, Anthocerotophyta (hornworts), is more evolutionarily advanced than other bryophyte divisions. They are represented by approximately 230 taxa worldwide (Söderström et al. 2016). Türkiye is between 26–46°E longitudes and 36–42°N latitudes, covering an area of 783,356 km² (Dönmez and Yerli 2019). As a peninsula country, it has a coastline of 8,333 km and land borders extending 2,875 km (Aytaç et al. 2020). Owing to its location at the convergence of the Euro-Siberian, Mediterranean, and Irano-Turanian phytogeographical regions, Türkiye harbors an exceptionally diverse flora (Efe 2010).

The scientific investigation of liverworts in Türkiye began in the late 1800s. The earliest known record is Wettstein's work titled "*Beiträge zur Flora des Orients*" (*Contributions to the Flora of the Orient*), which includes the first liverwort species reported from Türkiye: *Marchantia polymorpha* L.. During the early 1900s, foreign researchers collected bryophyte specimens during botanical expeditions conducted in various regions of Türkiye. Several researchers conducted bryological studies in various regions of Türkiye throughout the 20th century. Handel-Mazzetti explored the Eastern Black Sea Region in 1909; Schiffner worked in different parts of Türkiye in 1913; Reimers collected specimens from the northern regions in 1927; Bornmüller researched several areas in 1931. In 1955, Henderson & Muirhead studied the Central Anatolia, Mediterranean, and Eastern Black Sea regions. Subsequently, Henderson carried out further investigations in Eastern Anatolia (1958), followed by studies in the Black Sea and Mediterranean regions (1961a, 1961b, 1963). Robinson & Godfrey surveyed Türkiye in 1960. Walther & Leblebici focused on western Türkiye in 1969, while Walther also worked in Western Anatolia in 1967, 1970, and 1979. Crundwell & Nyholm conducted research in various regions of Türkiye in 1979. The bryophyte specimens collected were cataloged by Henderson & Prentice (1969), resulting in the documentation of 132 liverwort species for Türkiye. In addition to these records, Henderson (1961) developed a

map that divided Türkiye into 15 grid squares to illustrate the distribution of bryophytes (Figure 1).

Since the 1980s, local researchers in Türkiye have conducted studies on the division Hepaticae. Gökler et al. (1984) reported *Pellia neesiana* (Gottsche) Limpr. for the first time in Türkiye. Çetin & Yurdakul (1986) published the liverwort flora of Yedigöller National Park. Gökler et al. (1986) listed 143 liverwort species in the first national checklist compiled by Türkiye researchers. Later, Çetin (1988) expanded the systematic checklist of liverworts in Türkiye to 145 species. Kürschner and Erdağ (2005) presented a bryophyte checklist for Türkiye, reporting 163 liverwort taxa. Özenoğlu & Keçeli (2009) updated the liverwort and hornwort checklist for Türkiye, documenting 172 taxa and indicating their locations based on Henderson's (1961) grid system.

For research data conducted prior to 2009, it is recommended to refer to the publication by Özenoğlu & Keçeli (2009). In addition, the Türkiye Plant List – Mosses, published in 2017; Bryophyte Locality Data from the Near and Middle East – Volume 1, published in 2020; and Flora of Türkiye Mosses, published in 2023, were prepared in book form by Kürschner and Erdağ. These books provide extensive and important data, as well as detailed research, on Türkiye liverworts.

When we examine the important liverwort and hornwort studies conducted in Türkiye after 2009, according to Henderson's (1961) grid system; (The references for the species newly recorded for Türkiye are provided in the table notes. This section includes publications containing grid records.)

- Studies presenting square records for [A1]: Gözcü et al. (2018); Gözcü et al. (2019); Uslu & Keçeli (2019)
- Studies presenting square records for [A2]: Ursavaş & Abay (2009); Cangül & Ezer (2010); Şimşek et al. (2011); Ören et al. (2012); Ören et al. (2015); Gözcü et al. (2018); Sarıoğlu & Keçeli (2018); Gözcü et al. (2019); Ören & Ursavaş (2020)
- Studies presenting square records for [A3]: Söylemez et al. (2017); Çalışkan et al. (2019); Ören & Ursavaş (2020); Uyar & Ören (2025); Yücel et al. (2025)
- Studies presenting square records for [A4]: Erata et al. (2022); Özen et al. (2019)
- Studies presenting square records for [A5]: Batan et al. (2017)

- Studies presenting square records for [B6]: Şimşek (2024)
- Studies presenting square records for [B7]: Yücel and Ezer (2018); Gökler et al. (2022); Yücel et al. (2024)
- Studies presenting square records for [B8]: Gözcü et al. (2013); Kara et al. (2014); Karakaş & Ezer (2017)
- Studies presenting square records for [B10]: Kırmacı et al. (2018)
- Studies presenting square records for [C11]: Kırmacı & Erdağ (2010)
- Studies presenting square records for [C12]: Uygur et al. (2022a), Uygur et al. (2022b),
- Studies presenting square records for [C13]: Kara et al. (2013); Ezer et al. (2015)

Advancements in Molecular Biology and Genetics, combined with greater accessibility to previously unexplored regions and a growing research community, have significantly increased the number of cryptogam specimens recorded in Türkiye. The objective of this study is to compile an updated list of liverworts & hornworts in Türkiye and to map their distribution 16 years later (Table 1).

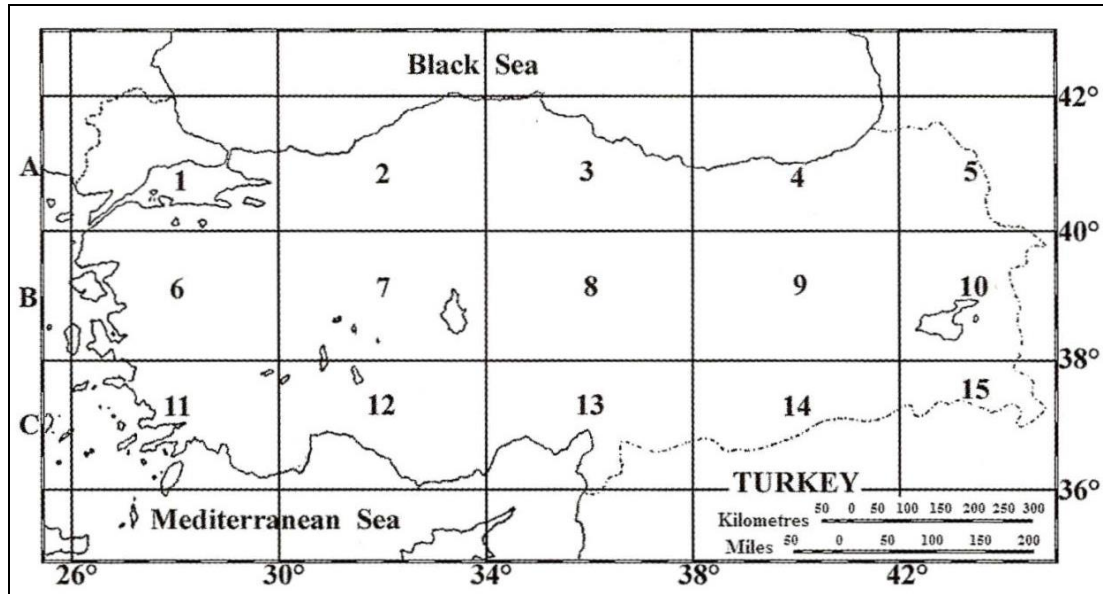


Figure1. Map of Türkiye according to Henderson (1961) quadrature system

2. Materials And Methods

The collection was compiled based on searches conducted in the Web of Science, Scopus, Google Scholar, ScienceDirect (Elsevier), SpringerLink, Wiley Online Library, TR Dizin databases and the analysis of the data forming the basis of this research was carried out with great precision. All national and international journals, symposium proceedings, postgraduate theses, congress proceedings, research notes, books, booklets and poster presentations containing information such as taxonomy, locality, new records, square records of Turkish liverworts and hornworts published after 2009 were meticulously scanned and the content of 128 articles was examined. Following this search, the data was tabulated, and to ensure continuity, the foundations of a database (Scanned database/Indexed publication form/Research subject/Province where the study was conducted/Authors/Year/Publication title/Journal title/Publication number, page/DOI number/Open

access status/Square record/New record for Turkey, and reference list) were created. During the literature review, care was taken not to overlook studies where liverworts and hornworts were not presented separately but were included in a common flora list with bryophytes. Publications necessary for the examination of ambiguous type data presented before and in the early 2000s have been accessed; however, it has not been possible to advance beyond the data presented in previous checklists. This is due to the highly limited nature of the data.

All taxa presented in the list were prepared according to the current and universal sequence, taking into account Söderström et al. (2016) World checklist of hornworts and liverworts and Hodgetts et al. (2020) An annotated checklist of bryophytes of Europe, Macaronesia and Cyprus. All updates resulting from changes in the synonymy of taxon names and the subspecific/varietal status of species

have been incorporated into this list. Species presented in the previous most recent list that have fallen into synonymy are also addressed in the notes. This will facilitate researchers' access to current names when consulting the table in new studies. References for all species constituting new records for Türkiye are provided in the notes below the table. The exact repositories of each recorded species could not be detailed due to a lack of precise information on the herbaria where they are stored. Another reason for the omission of herbarium data is that researchers often maintain their own personal herbarium records. A detailed study has been conducted on endemic species; however, as noted in Kürschner and Erdağ (2023), the most recent and comprehensive Turkish identification guide, *Flora of Türkiye: Keys in Two Languages for the Identification of Hornworts, Liverworts and Leafy Mosses*, uncertainties regarding endemic species persist and further research is required to resolve these uncertainties.

In preparing this list, attention was paid to rectifying the shortcomings of previous lists and incorporating innovative aspects from other global checklists. For example, the fluidity and easily

traceable nature of the table in Hodgetts (2015) Checklist and country status of European bryophytes – towards a new Red List for Europe were specifically considered. The primary reasons for presenting the table horizontally and incorporating colors are to ensure that every reader can quickly access the desired data without losing continuity or having to return to the beginning.

In 2012, within the scope of the project for writing the *Flora of Türkiye* under the NGBB-ANG Foundation, an updated mapping system replaced Davis's grid system for Türkiye. However, for the presentation of bryophytes, Henderson's (1961) grid system, specifically developed for cryptogams, maintains its novelty and continues to be used by researchers. For this reason, the table was designed and prepared for presentation following the Henderson (1961) grid system.

3. Findings

As the findings of this research, the current list of liverwort and hornwort taxa in Türkiye and their distribution according to the Türkiye map grid system (Henderson, 1961) are given in Table 1.

Table 1. An up-to-date list of Türkiye's liverwort and hornwort taxa and their distributions

[illegible]

[illegible]

NO	TAXON	A					B					C				
	JUNGERMANNIOPSIDA STOTLER & CRAND.-STOTL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
129.	<i>Cololejeunea rossettiana</i> (C.Massal.) Schiffn.	■	●	■	●								■	■		
130.	<i>Lejeunea cavifolia</i> (Ehrh.) Lindb.	●	●	●	●		●	●			■	●	■	■		
131.	<i>Lejeunea lamacerina</i> (Steph.) Schiffn.	●	●	●	●		●	◆				●	●			
132.	<i>Lejeunea patens</i> Lindb.		●		●									■		
133.	<i>Microlejeunea ulicina</i> (Taylor) Steph. [27]				●											
Porellaceae Cavers																
134.	<i>Porella arboris-vitae</i> (With.) Grolle	■	●	■	●		●					●		■		
135.	<i>Porella baueri</i> (Schiffn.) C.E.O.Jensen						●	●				●				
136.	<i>Porella cordaeana</i> (Huebener) Moore	●	●	●	●	■	●	●				●	●	●		
137.	<i>Porella obtusata</i> (Taylor) Trevis.	■	■	●	●	■	●					■		■		
138.	<i>Porella pinnata</i> L.		■	■	■	■	■					●	●	■		
139.	<i>Porella platyphylla</i> (L.) Pfeiff.	●	●	●	●	●	●	●	●			●	●	●		
Radulaceae Müll.Frib.																
140.	<i>Radula complanata</i> (L.) Dumort.	●	●	●	●	●	●	●				●	●	●		
141.	<i>Radula lindenbergiana</i> Gottsche ex C.Hartm.	●	●	●	●	■	●					●		■		
Ptilidiaceae H.Klinggr.																
142.	<i>Ptilidium pulcherrimum</i> (Weber) Vain. [28]		●	●	■											
Aneuraceae H.Klinggr.																
143.	<i>Aneura pinguis</i> (L.) Dumort	■	■	■	●	■	■					●	●	■		
144.	<i>Riccardia chamedryfolia</i> (With.) Grolle		■	■	●		●									
145.	<i>Riccardia latifrons</i> (Lindb.) Lindb.		●													
146.	<i>Riccardia multifida</i> (L.) Gray	■	■	■	●					●				■		
147.	<i>Riccardia palmata</i> (Hedw.) Carruth.		●	■	●								■	■		
Metzgeriaceae H.Klinggr.																
148.	<i>Metzgeria conjugata</i> Lindb.	●	●	●	●	●	●	●				●	■	●		
149.	<i>Metzgeria furcata</i> (L.) Corda	●	●	●	●	●	●	●				●	●	●		
150.	<i>Metzgeria pubescens</i> (Schränk) Raddi [29]		●	●	●											
Fossombroniaceae Hazsl.																
151.	<i>Fossombronia angulosa</i> (Dicks.) Raddi	●	●	■	●		●	◆				●	●	■		
152.	<i>Fossombronia caespitiformis</i> (Raddi) De Not. ex Rabenh. subsp. <i>caespitiformis</i>	■					●					●	●			
153.	<i>Fossombronia caespitiformis</i> (Raddi) De Not. ex Rabenh. subsp. <i>multispira</i> (Schiffn.) J.R.Bray & Cargill	●	■									●				
154.	<i>Fossombronia echinata</i> Macvicar [76]											*	■			

NO	TAXON	A	B	C
JUNGERMANNIOPSIDA STOTLER & CRAND.-STOTL.				
155.	<i>Fossombronina foveolata</i> Lindb. [30]			
156.	<i>Fossombronina maritima</i> (Paton) Paton [77]	*		
157.	<i>Fossombronina pusilla</i> (L.) Nees	•	♦	■
158.	<i>Fossombronina wondraczekii</i> (Corda) Dumort. ex Lindb.			•
Petalophyllaceae Stotler & Crand.-Stotl.				
159.	<i>Petalophyllum ralfsii</i> (Wilson) Nees & Gottsche		•	•
Pallaviciniaceae Mig.				
160.	<i>Pallavicinia lyellii</i> (Hook.) Gray			
Pelliaceae H.Klinggr.				
161.	<i>Apopellia endiviifolia</i> (Dicks.) Nebel & D.Quandt [31]	•	•	•
162.	<i>Pellia epiphylla</i> (L.) Corda	•	•	•
163.	<i>Pellia neesiana</i> (Gottsche) Limpr.	•	■	■
MARCHANTIOPSIDA CRONQUIST, TAKHT. & W.ZIMM.				
Blasiaceae H.Klinggr.				
164.	<i>Blasia pusilla</i> L.	■	•	•
Lunulariaceae H.Klinggr.				
165.	<i>Lunularia cruciata</i> (L.) Dumort. ex Lindb.	•	•	•
Aytoniaceae Cavers				
166.	<i>Asterella saccata</i> (Wahlenb.) A.Evans [78]			*
167.	<i>Mannia androgyna</i> (L.) A.Evans		•	•
168.	<i>Mannia fragrans</i> (Balb.) Frye & L.Clark [32]			■
169.	<i>Mannia gracilis</i> (F.Weber) D.B.Schill & D.G.Long [33]	•	■	•
170.	<i>Plagiochasma rupestre</i> (J.R.Forst. & G.Forst.) Steph.		•	•
171.	<i>Reboulia hemisphaerica</i> (L.) Raddi [44]	•	•	•
Cleveaceae Cavers				
172.	<i>Clevea hyalina</i> (Sommerf.) Lindb. [34]	•		•
173.	<i>Clevea spathysii</i> (Lindenb.) Müll.Frib. [35]			•
Conocephalaceae Müll.Frib. ex Grolle				
174.	<i>Conocephalum conicum</i> (L.) Dumort.	•	♦	•
Corsiniaceae Engl.				

NO	TAXON	A					B					C				
	MARCHANTIOPSIDA CRONQUIST, TAKHT. & W.ZIMM.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
175.	<i>Corsinia coriandrina</i> (Spreng.) Lindb.	■	●	■			●					●	●	■		
Marchantiaceae Lindl.																
176.	<i>Marchantia paleacea</i> Bertol.			●	●								●			
177.	<i>Marchantia polymorpha</i> L. subsp. <i>montivagans</i> Bischl. & Boissel.-Dub.	●	■	■		■	●			●	■			■		
178.	<i>Marchantia polymorpha</i> L. subsp. <i>polymorpha</i>	●	●	●	●	●	●	●	●	●		●	●	●		●
179.	<i>Marchantia polymorpha</i> L. subsp. <i>ruderalis</i> Bischl. & Boissel.-Dub. [36]													■		
180.	<i>Marchantia quadrata</i> Scop. [79]		*									■	■	■		
Oxymitraceae Müll.Frib. ex Grolle																
181.	<i>Oxymitra incrassata</i> (Brot.) Sérgio & Sim-Sim						●					●	●	■		
Ricciaceae Rchb.																
182.	<i>Riccia atromarginata</i> Levier [80]											*				
183.	<i>Riccia beyrichiana</i> Hampe [81]		■									*				
184.	<i>Riccia bicarinata</i> Lindb.	■					●					●	●			
185.	<i>Riccia bifurca</i> Hoffm.	■			■		■		●		■	●	■			
186.	<i>Riccia ciliata</i> Hoffm.		■				●					●	●			
187.	<i>Riccia ciliifera</i> Link	●					●									
188.	<i>Riccia crinita</i> Taylor [82]						*					*				
189.	<i>Riccia crozalsii</i> Levier	●	■	■			■					●	■	■		
190.	<i>Riccia glauca</i> L. var. <i>ciliaris</i> Warnst.											●				
191.	<i>Riccia glauca</i> L. var. <i>glauca</i>	■				■	●		■			●	●	■		
192.	<i>Riccia gougetiana</i> Durieu & Mont. var. <i>armatissima</i> Levier ex Müll.Frib. [37]						■									
193.	<i>Riccia gougetiana</i> Durieu & Mont. var. <i>gougetiana</i>	■	■				●					●	■			
194.	<i>Riccia lamellosa</i> Raddi [37]						■					■		■		
195.	<i>Riccia macrocarpa</i> Levier	■					●					●	■			
196.	<i>Riccia michelii</i> Raddi						■					●	●			
197.	<i>Riccia nigrella</i> DC.	●	■	■			●					●	●	■		
198.	<i>Riccia papillosa</i> Moris [38]	■			■		■		■			●	■			
199.	<i>Riccia sorocarpa</i> Bisch.	■	■	■		●	●		■			●	●	■	■	■
200.	<i>Riccia subbifurca</i> Warnst. ex Croz. [83]	■	*	■			■					■				
201.	<i>Riccia trabutiana</i> Steph. [39]											■				
202.	<i>Riccia canaliculata</i> Hoffm. [37]		■										■			

NO	TAXON	A					B					C				
MARCHANTIOPSIDA CRONQUIST, TAKHT. & W.ZIMM.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
203.	<i>Riccia fluitans</i> L.		■									●				
204.	<i>Riccia frostii</i> Austin			●								●				●
205.	<i>Riccia perennis</i> Steph. [84]						■					*				
206.	<i>Riccia rhenana</i> Lorb. ex Müll.Frib.						●									
207.	<i>Riccia cavernosa</i> Hoffm. [85]		■	■										*		
208.	<i>Riccia crystallina</i> L.	■					●					■	■			
209.	<i>Riccia anatolica</i> Özenoğlu & Kırmacı [86]												*			
210.	<i>Ricciocarpos natans</i> (L.) Corda		●	■												
Targioniaceae Dumort.																
211.	<i>Targionia hypophylla</i> L.	●	●	■			●	●				●	●	●		
212.	<i>Targionia lorbeeriana</i> Müll.Frib.						●					●				
Riellaceae Engl.																
213.	<i>Riella helicophylla</i> (Bory & Mont.) Mont. [40]															
Sphaerocarpaceae Heeg																
214.	<i>Sphaerocarpos europaeus</i> Lorb.						●					●	●			
215.	<i>Sphaerocarpos michelii</i> Bellardi						●					●	■	■		
ANTHOCEROTOPHYTA		The Distribution of The Hornworts in Türkiye														
NO	TAXON	A					B					C				
ANTHOCEROTOPSIDA DE BARY EX JANCZ.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Anthocerotaceae Dumort.																
216.	<i>Anthoceros caucasicus</i> Steph. [89]	■	■		*											
217	<i>Anthoceros punctatus</i> L.	●	●	●	●		●					●	●			
Phymatocerotaceae R.J.Duff																
218	<i>Phymatoceros bulbiculosus</i> (Brot.) Stotler			■			●									
Notothyladaceae Müll.Frib. ex Prosk.																
219.	<i>Phaeoceros laevis</i> (L.) Prosk.	●	■	■	●	■	●					●	●			
Total number of taxa reported for each square:		95	121	90	136	50	84	34	20	5	9	84	69	63	1	3
[*]: Symbol signifies new record for Türkiye.								[■]: Symbol signify new records for individual square.								
[●]: Symbol signify former reports.								[◆]: Symbol signifies new records done by us.								

Table Brief Notes:

- [1] Syn: *Jamesoniella autumnalis* (DC.) Steph.
 [2] Syn: *Lophozia lycopodioides* (Wallr.) Cogn.
 → This species has been reported by Keçeli et al. (2011) from Türkiye.
 [3] Syn: *Lophozia rubescens* R.M. Schust. & Damsh.
 [4] Syn: *Jungermannia sudetica* Nees ex Huebener, *Lophozia sudetica* (Nees ex Huebener) Grolle
 [5] Syn: *Jungermannia bicrenata* Schmidel ex Hoffm., *Lophozia bicrenata* (Schmidel ex Hoffm.) Dumort.
 [6] Syn: *Barbilophozia attenuata* (Mart.) Loeske
 [7] Syn: *Cephalozia catenulata* (Huebener) Lindb.
 [8] Syn: *Cephalozia pleniceps* (Austin) Lindb.
 [9] Syn: *Cladopodiella fluitans* (Nees) H. Buch
 [10] Syn: *Tritomaria quinqueidentata* (Huds.) H. Buch
 [11] Syn: *Jungermannia incisa* Schrad., *Lophozia incisa* (Schrad.) Dumort.
 [12] Syn: *Anthelia julacea* subsp. *juratzkana* (Limpr.) Meyl.
 [13] Syn: *Jungermannia leiantha* Grolle
 [14] Syn: *Jungermannia badensis* Gottsche ex Rabenh., *Leiocolea badensis* (Gottsche ex Rabenh.) Jørg.
 → "This species has been reported by Çetin (1988) from Türkiye without collection data and locality."
 [15] Syn: *Jungermannia bantriensis* Hook., *Leiocolea bantriensis* (Hook.) Jørg.
 [16] Syn: *Leiocolea collaris* (Nees) Schljakov, *Leiocolea alpestris* (Schleich. ex F. Weber) Isov.
 [17] Syn: *Jungermannia turbinata* Raddi, *Leiocolea turbinata* (Raddi) H. Buch
 [18] Syn: *Jungermannia obovata* Nees
 [19] Syn: *Jungermannia gracillima* Sm.
 [20] Syn: *Jungermannia handelii* (Schiffn.) Amakawa
 [21] Syn: *Jungermannia hyalina* Lyell
 [22] Syn: *Jungermannia caucasica* Váňa
 [23] Syn: *Jungermannia sphaerocarpa* Hook.
 [24] Syn: *Jungermannia lignicola* (Schiffn.) Grolle → Endemic species to Türkiye
 [25] Syn: *Jungermannia subtilissima* (Schiffn.) Grolle → Endemic species to Türkiye
 [26] Syn: *Lophocolea bidentata* var. *rivularis* (Raddi) Schiffn.
 [27] Syn: *Lejeunea ulicina* (Taylor) Gottsche, Lindenb. & Nees
 [28] Syn: *Jungermannia pulcherrima* Weber
 [29] Syn: *Apometzgeria pubescens* (Schränk) Kuwah.
 [30] → "The species *Fossombronina foveolata* Lindb. has been reported by Smith (1990) from Türkiye without locality data."
 [31] Syn: *Pellia endiviifolia* (Dicks.) Dumort.
 [32] → "This species has been reported by Çetin (1988) from Türkiye without collection data and locality."
 [33] Syn: *Asterella gracilis* (F. Weber) Underw.
 [34] Syn: *Athalamia hyalina* (Sommerf.) S.Hatt.
 [35] Syn: *Athalamia spathysii* (Lindenb.) S.Hatt.
 [36] → "This taxon was reported by Ros et al. (2007) from Türkiye without collection data and locality."
 [37] → "This taxon was reported by Jovet-Ast (1986) from Türkiye without collection data and locality."
 [38] → "This species has been reported by Çetin (1988) from Türkiye without collection data and locality."
 [39] → "This taxon was reported by El-Oqlah et al. (1988) from Türkiye without collection data and locality."
 [40] → "This species has been reported by Çetin (1988) from Türkiye without collection data and locality."
 [41] → "According to Kürschner (2013) all doubtful records for Türkiye as the taxon has an American distribution pattern. Almost certainly, the Türkiye records all belong to. *Jubula hutchinsiae* subsp. *caucasica*"
 [42] Syn: *Marsupella funckii* var. *major* (Nees) Boulay
 [43] Syn: *Plagiochila asplenoides* var. *riparia* Breidl.
 [44] *Reboulia hemisphaerica* var. *macrocephala* Massal. in Sommer / *Reboulia hemisphaerica* var. *microspora* Schiffn.
 → "The taxonomic status of this infrageneric, endemic variety given for Türkiye is doubtful (Kürschner & Frey 2011)
 [45] Syn: *Scapania undulata* var. *dentata* (Dumort.) McArdle
 [46] → "This species has been reported by Unan and Ören (2021) from Türkiye."
 [47] → "This species has been reported by from Erata and Batan (2020) Türkiye."
 [48] → "This species has been reported by Ezer et al. (2013) from Türkiye."
 [49] → "This species has been reported by Unan and Ören (2021) from Türkiye."
 [50] → "This species has been reported by Gözcü et al. (2019) from Türkiye."
 [51] → "This species was collected recently (2012-2013) by local researchers. It is not known for sure who recorded the species"
 [52] → "This species has been reported by Ören et al. (2015) from Türkiye."
 [53] → "This species has been reported by Ören et al. (2017) from Türkiye."
 [54] → "This species has been reported by Erata et al. (2021) from Türkiye."
 [55] → "This species has been reported by Ezer et al. (2013) from Türkiye."
 [56] → "This species has been reported by Unan and Ören (2021) from Türkiye."
 [57] → "This species has been reported by Batan et al. (2024) from Türkiye."
 [58] → "This species has been reported by Batan et al. (2024) from Türkiye."
 [59] → "This species has been reported by Gözcü et al. (2019) from Türkiye."
 [60] → "This species has been reported by Batan et al. (2024) from Türkiye."
 [61] → "This species has been reported by Batan et al. (2022) from Türkiye."
 [62] → "This species has been reported by Unan et al. (2021) from Türkiye."
 [63] → "This species has been reported by Kara et al. (2014) from Türkiye."
 [64] → "This species has been reported by Unan et al. (2021) from Türkiye."
 [65] → "This species has been reported by Unan and Ören (2021) from Türkiye."
 [66] → "This species has been reported by Erata and Batan (2020) from Türkiye."
 [67] → "This species has been reported by Erata (2022) from Türkiye."
 [68] → "This species has been reported by Abay et al. (2022) from Türkiye."
 [69] → "This species has been reported by Batan et al. (2024) from Türkiye."
 [70] → "This species has been reported by Kara et al. (2014) from Türkiye."
 [71] → "This species has been reported by Batan et al. (2024) from Türkiye."
 [72] → "This species has been reported by Batan et al. (2013) from Türkiye."
 [73] → "This species has been reported by Keçeli et al. (2012) from Türkiye."
 [74] → "This species has been reported by Keçeli and Abay (2012) from Türkiye."
 [75] → "This species has been reported by Özdemir and Batan (2016) Türkiye."
 [76] → "This species has been reported by from Kırmacı and Erdağ (2009) Türkiye."
 [77] → "This species has been reported by from Papp and Sabovljević (2003) Türkiye."
 [78] → "This species has been reported by Kırmacı et al. (2021) from Türkiye."
 [79] → "This species has been reported by Şimşek et al. (2014) from Türkiye."
 [80] → "This species has been reported by from Özenoğlu et al. (2019) Türkiye."
 [81] → "This species has been reported by Özenoğlu Kiremit et al. (2016) from Türkiye."
 [82] → "This species has been reported by Özenoğlu Kiremit et al. (2016) from Türkiye."
 [83] → "This species has been reported by Özenoğlu Kiremit (2011) from Türkiye."
 [84] → "This species has been reported by Özenoğlu Kiremit and Hugonnot (2010) from Türkiye."
 [85] → "This species has been reported by Özenoğlu Kiremit et al. (2016) from Türkiye."
 [86] → "This species has been reported by Özenoğlu and Kırmacı (2022) from Türkiye."
 [87] → "This species has been reported by Erata et al. (2025)"
 [88] → "This species has been reported by Erata et al. (2025)"
 [89] → "This species has been reported by Kırmacı et al. (2012)"

4. Result and Discussion

As a result of the review of published records, a reference list comprising 219 taxa belonging to 80 genera and 45 families was presented. Among the taxa, 142 are leafy, 9 are transitional forms, and 68 are thalloid forms. The families with the highest number of taxa are Ricciaceae with 28 species, Scapaniaceae with 24 species, and Anastrophyllaceae, Cephaloziellaceae, and Jungermanniaceae, each represented by 10 species. This study, conducted after a 16-year hiatus, has identified 45 new species records and 280 new grid records for Türkiye. The families with the highest number of species recorded are Scapaniaceae (10 species), Ricciaceae (7 species), and Cephaloziellaceae (6 species). The Ricciaceae family, which contains the highest number of species in Türkiye's liverwort flora, was revised for Türkiye by Kırmacı & Özenoğlu (2019). In the same study, the species *Riccia anatolica* Özenoğlu & Kırmacı was introduced to the literature.

The highest number of new species, 11 taxa, was recorded for grid square A2 (Western Black Sea Region). The grid square with the most new grid data is C13 (Adana Region) with 50 taxa, followed by A3 (Central Black Sea Region) with 45 taxa. Grid square A2, which has the highest number of species records, is the region where the most intensive bryophyte studies have been conducted. According to grid data, the A2/A3 squares within the Black Sea Region are among the areas most frequented by cryptogam researchers due to their suitable habitat characteristics. Grid square C13 has been an area with little to no prior research on Turkish bryophytes. However, recent studies by Kara et al. (2013) have highlighted that the region contains ideal habitats for liverworts.

The squares with the highest number of taxa reported were A4 (136 taxa), A2 (121 taxa), and A1 (95 taxa), while the squares with the fewest records were C14 (1 taxa), C15 (3 taxa), and B9 (5 taxa). This situation is due to factors such as the climatic, geological, ecological, geographical, and phytosociological characteristics of the geographic region, as well as the accessibility of the area, distance to the universities where the thesis was conducted, and security conditions (state of extraordinary zones, etc.). Since security and transportation/access problems to research areas have largely been eliminated, conducting taxonomic research in these localities with low square records will be an important step toward revealing the true potential of both these squares and Türkiye's liverwort and hornwort flora.

Bryophyte species represent the terrestrial plant group with the second-highest biodiversity after seed plants. Regions with little or no data on Hepaticae and Hornwort species, as well as areas with ecologically suitable habitats, have the potential to yield new findings through floristic research. In addition to

floristic investigations, the application of molecular analysis techniques should be incorporated to further support the morphological and anatomical characteristics of bryophytes. Moreover, there is an urgent need for an action plan aimed at the conservation of Türkiye's bryophyte species, with the immediate classification of these species under the appropriate IUCN Red List categories, in accordance with global standards.

Declaration

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Author contributions

Idea/Concept: KMY, HT, TK, IG; Conceptualization and design: KMY, HT, TK, IG; Auditing consulting: KMY, HT, TK, IG; References: KMY, HT, TK, IG; Materials: KMY, HT, TK, IG; Data collection and/or processing: KMY, HT, TK, IG; Analysis and/or interpretation: KMY, HT, TK, IG; Literature search: KMY, HT, TK, IG; Writing phase: KMY, HT, TK, IG; Critical review: KMY, HT, TK, IG.

Conflict of interest

It is declared by the authors that no conflict of interest exists concerning the findings and overall content of the study.

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Ethical approval

This research was conducted under in vitro conditions and therefore does not require ethical approval.

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