www.biodicon.com Biological Diversity and Conservation

ISSN 1308-8084 Online; ISSN 1308-5301 Print 9/2 (2016) 84-95

*Research article/Araştırma makalesi*

# Identification of some lichenized fungi species of Erciyes Mountain (Kayseri/Turkey) by using ITS (rDNA) marker

Mehmet Ünsal BARAK[1], Mehmet Gökhan HALICI [*1], Mithat GÜLLÜ[1]

[1] University of Erciyes, Faculty of Science, Department of Biology, 38039, Kayseri, Turkey

**Abstract**

In this study; we analysed the ITS sequences of 9 lichenized fungi species (*Aspicilia cinerea*, *Circinaria contorta*, *Lecidea atrobrunnea*, *Lecanora rupicola*, *Physcia dubia*, *Rhizoplaca peltata*, *Rhizocarpon geographicum*, *Tephromela atra* and *Xanthoparmelia pulla*) which have a wide distribution in the alpine zone of Erciyes Volcanic Mountain in Central Anatolia. ITS sequence data obtained from those 9 species are deposited by us in GenBank for further molecular studies and Neighbor-joining dendrograms with related species obtained from GenBank are also presented here along with the macroscopic photographs of the specimens studied. Besides, morphological and ecological differences between the related species are discussed.

**Key words: :** Lichens, biodiversity, systematics, taxonomy

---------- * ----------

# ITS (rDNA) marker kullanılarak Erciyes Dağı'nın (Kayseri, Türkiye) bazı likenleşmiş mantar türlerinin tanımlanması

**Özet**

Bu çalışmada, Orta Anadolu'da yer alan Erciyes Dağı'nın alpin zonunda yayılış gösteren 9 yaygın likenleşmiş mantar türüne ait örneklerin (*Aspicilia cinerea*, *Circinaria contorta*, *Lecidea atrobrunnea*, *Lecanora rupicola*, *Physcia dubia*, *Rhizoplaca peltata*, *Rhizocarpon geographicum*, *Tephromela atra* ve *Xanthoparmelia pulla*) ITS dizi analizleri elde edilmiştir. Bu 9 türden elde edilen ITS sekans verileri ileride yapılacak moleküler çalışmalar da kullanılması için Gen Bankası'na yüklenmiştir. Ayrıca Gen Bankası'ndan temin edilen ilişkili türler ile hazırlanan Neighbor-joining dendrogramlar ve çalışılan örneklere ait makroskobik fotoğraflar da verilmiştir. Ayrıca ilişkili türler arasında morfolojik ve ekolojik farklılıklar da tartışılmıştır.

**Anahtar kelimeler:** Liken, biyoçeşitlilik, sistematik, taksonomi

## 1. Introduction

The first lichen checklist of Erciyes Mountain was published by Steiner (1905). In that study, 83 lichenized taxa were reported. In the first period of 21st century; Güvenç (2001) reported 40 taxa and John (2002) reported 2 taxa from Erciyes Mountain. Later Halıcı et. al. (2005) compiled 223 lichenized and lichenicolous fungi taxa in Erciyes Mountain. After this study 9 more lichen and lichenicolous fungi taxa were added in the checklist of Erciyes Mountain (Halıcı et. al. 2006; 2007; 2014) and the number of lichenized and lichenicolous fungus taxa reached to 232.

The taxonomic studies on lichenized fungi in Turkey based on morphological and anatomical characters recently started (Türk et. al. 2015). However, analysis of nuclear rDNA is increasingly becoming important for lichen taxonomy. Among the ribosomal regions, the internal transcribed spacer (ITS) region has the highest probability of successful identification for the broadest range of fungi. In some cases, morphological and anatomical characters for identification of lichens in species level may be insufficient (Arup et. al. 2013, Vondrák et. al. 2016). For this reason; we start to analyze the ITS sequence data of lichenized fungi species previously reported in Erciyes Mountain. Here we

* *Corresponding author* / Haberleşmeden sorumlu yazar: Tel.: +903524375261; Fax.: +903524375261; E-mail: mghalici@gmail.com
 BioDiCon. 509-1215

present 10 ITS sequence data and related Neighbor-joining dendrodgrams of 9 lichenized fungi taxa from Erciyes Mountain.

## 2. Materials and methods

### *2.1. Lichen material*

Lichen specimens (*Aspicilia cinerea*, *Circinaria contorta*, *Lecidea atrobrunnea*, *Lecanora rupicola*, *Physcia dubia*, *Rhizoplaca peltata*, *Rhizocarpon geographicum*, *Tephromela atra* and *Xanthoparmelia pulla*) stored in ERC (Erciyes University herbarium) were used for this study.

### *2.2. Extraction of DNA and PCR Amplification*

Ten lichen samples were used for DNA extraction. DNA was extracted using protocol of Qiagen Dneasy Plant Kit (Cat. No: 69104). PCR was carried out in 50 µL reaction volumes using 4 µl of 10 x reaction buffer, 4 µl $MgCl_2$ (50 mM) , 0.5 µl each primer, 1 µl dNTP (10 mM), 0.1 µl Taq DNA polymerase, 3 µl of genomic DNA and 36.9 µl $dH_2O$ on a thermal cycler equipped with a heated lid. Primers used for PCR amplification of ITS regions were ITS1-F (5′-CTTGGTCATTTAGAGGAAGTAA-3′) (Gardes and Bruns 1993) and ITS4 (5'-TCCTCCGCTTATTGATATGC-3') (White et. al. 1990). The PCR was performed under the following conditions: An initial denaturation 4 min at 95 °C; 7 cycles with 1 min at 94 °C, 1 min at 55 °C, and 2 min at 72 °C; and 33 cycles with 1 min at 94 °C, 1 min at 52 °C, and 2 min at 72 °C; a final extension step of 5 min at 72 °C was added, after which the samples were kept at 4 °C. PCR products run on agarose gel and sequence analysis of ten lichen samples from which DNA bands were obtained was done.

### *2.3. Phylogenetic analysis*

Sequence results of the lichen samples were compared using BLAST program in NCBI website. Then, the results were edited in BioEdit program. Sequences were aligned by using Clustal w option in the BioEdit program. For phylogenetic tree, MEGA 6 (Molecular Evolutionary Genetics Analysis) program was used and genetic distances were determined by method Kimura-2-parameter. Phylogenetic trees of the lichen samples were performed by using neighbor-joining method (Tamura et. al. 2013).

Table 1. The studied specimens, herbarium numbers and GenBank accession numbers

| **Species name** | **Herbarium number** | **GenBank accessions number** |
|---|---|---|
| *Aspicilia cinerea* | ERC MB 0.002 | KX550108 |
| *Aspicilia cinerea* | ERC MGH 0.018 | KX550104 |
| *Circinaria contorta* | ERC MGH 0.139 | KX550106 |
| *Lecidea atrobrunnea* | ERC MB 0.008 | KX550101 |
| *Lecanora rupicola* | ERC MB 0.010 | KX550102 |
| *Physcia dubia* | ERC MGH 0.025 | KX550105 |
| *Rhizoplaca peltata* | ERC MB 0.003 | KX550109 |
| *Rhizocarpon geographicum* | ERC MB 0.011 | KX550103 |
| *Tephromela atra* | ERC MB 0.004 | KX550110 |
| *Xanthoparmelia pulla* | ERC MB 0.001 | KX550107 |

## 3. Results

Descriptions, photographs and discussions of lichenized fungus species studied for this paper are given below.

**3.1. *Aspicilia cinerea*** (L.) Körb. **Figure 1**

**Specimens examined:** Turkey, Kayseri, Talas; Erciyes Mountain, Ali Mountain, 38° 40′ 476″ N, 35° 32′ 993″ E, alt. 1380 m, 06.04.2015 **[ERC MB 0.002]**; Kayseri, Erciyes Mountain, Yılanlı Mountain, in the vicinity of Koyunbaba, 38° 43′ N, 35° 26′ E, alt. 1205 m, 29.06.2003 **[ERC MGH 0.018]**.

Thallus cracked-areolate, 2─3.5 cm in diam; areoles usually irregular, (0.3─)0.6─*1*─1.4 mm in diam. Thallus surface whitish gray, sometimes yellowish white. Apothecia numerous and aspicilioid type, ranging in number from 1 to 10 per areole, (0.15─)0.2─*0.25*─0.3(─0.35) mm in diam. Apothecia disc black; usually pruinose. Thallus and medulla K─, C─, KC─, Pd + yellow-orange. Epihymenium greenish or brownish green. Hymenium hyaline. Paraphyses moniliform. Asci clavate, (80─)82─*98*─114(─120) × 14─*19*─24(─26) µm. Ascospores not observed. This species has a wide distribution in subarctic and

arctic-alpine areas in the Northern Hemisphere (Purvis 1992). It has also wide distribution in Turkey especially in subalpine and alpine areas of Turkey on hard siliceous rocks (e.g. Halıcı & Güvenç 2008, Çobanoğlu et al. 2013).

**Table 2.** Bant sizes and nucleotide variable sites of the specimens studied

| Species name | PCR results | Sequence results | Bant size (bp) | Nucleotide variable sites |
|---|---|---|---|---|
| *Aspicilia cinerea* (ERC MB 0.002 and ERC MGH 0.018) | + | + | 800 | 344 |
| *Circinaria contorta* (ERC MGH 0.139) | + | + | 750 | 218 |
| *Lecidea atrobrunnea* (ERC MB 0.008) | + | + | 560 | 182 |
| *Lecanora rupicola* (ERC MB 0.010) | + | + | 600 | 130 |
| *Physcia dubia* (ERC MGH 0.025) | + | + | 790 | 201 |
| *Rhizoplaca peltata* (ERC MB 0.003) | + | + | 589 | 167 |
| *Rhizocarpon geographicum* (ERC MB 0.011) | + | + | 530 | 196 |
| *Tephromela atra* (ERC MB 0.004) | + | + | 580 | 114 |
| *Xanthoparmelia pulla* (ERC MB 0.001) | + | + | 568 | 93 |

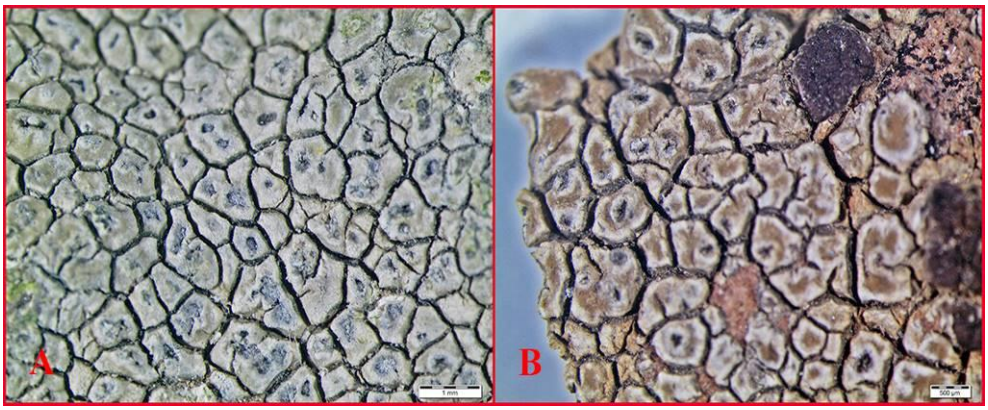


Figure 1. *Aspicilia cinerea* A. ERC MB 0.002 B. ERC MGH 0.018

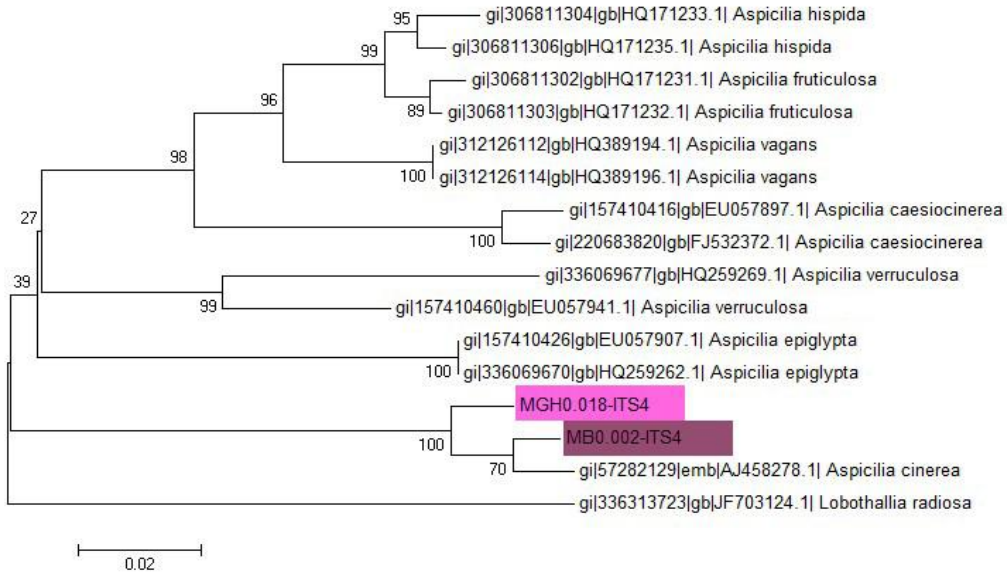


Figure 2. Neighbor-Joining (NJ) dendrogram of *Aspicilia cinerea* and related species (ERC MB 0.002 and ERC MGH 0.018)

In the NJ dendrogram (Figure 2); it is clear that our samples from Erciyes Mountain (ERC MB 0.002 and ERC MGH 0.018) is branching with *Aspicilia cinerea*. The closest branching to *A. cinerea* is *A. epiglypta* (Norrl. ex Nyl.) Hue. There are significant morphological and anatomical differences between *A. cinerea* and *A. epiglypta. A. epiglypta* has longer conidia than *A. cinerea*. In addition, while *A. cinerea* has a distribution in subarctic and arctic-alpine areas, *A. epiglypta* has a distribution in the coastal areas (Nordin et al. 2007). *A. cinerea* is also morphologically quite similar to *A. intermutans* but the latter species has smaller conidia and larger mature ascospores (Fryday 1997).

**3.2. *Circinaria contorta*** (L.) A.Nordin, Savić & Tibell **Figure 3**

**Specimen examined:** Tukey, Kayseri, Erciyes Mountain; İncesu, Sürtme (Western part of Erciyes Mountain), 38° 35′ N, 35° 36′ E, alt. 1100 m, 27.05.2003 **[ERC MGH 0.139]**.

Thallus saxicolous, pale brownish; cracked-areolate. Areoles irregular and discrete, (0.3–)0.5–*0.8*–1.1(–1.2) mm in diam. Prothallus not visible. Apothecia irregular, numerous and aspicilloid; blackish especially young apothecia pruinose, (0.15–)0.2–*0.25*–0.3(–0.4) µm in diam. All spot tests negative.

This species has a wide distribution on calcareous rocks and limestone in Northern Hemisphere (Purvis 1992). It has also very wide distribution in Turkey on siliceous and weakly calcareous rocks (e.g. Oran et al. 2007, Halıcı & Aksoy 2009).

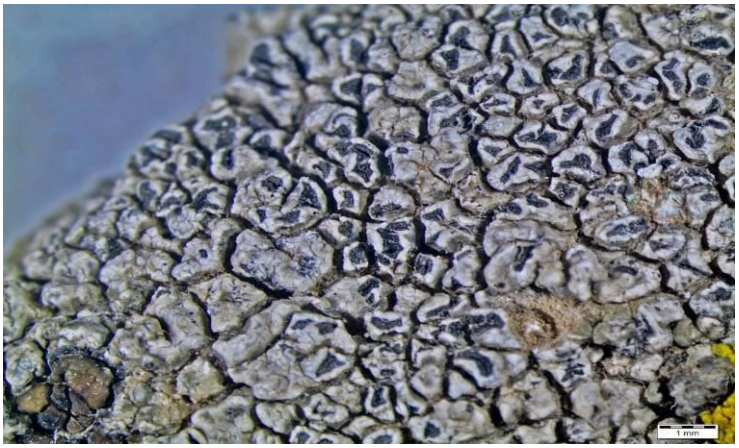

Figure 3. *Circinaria contorta* (ERC MGH 0.139)

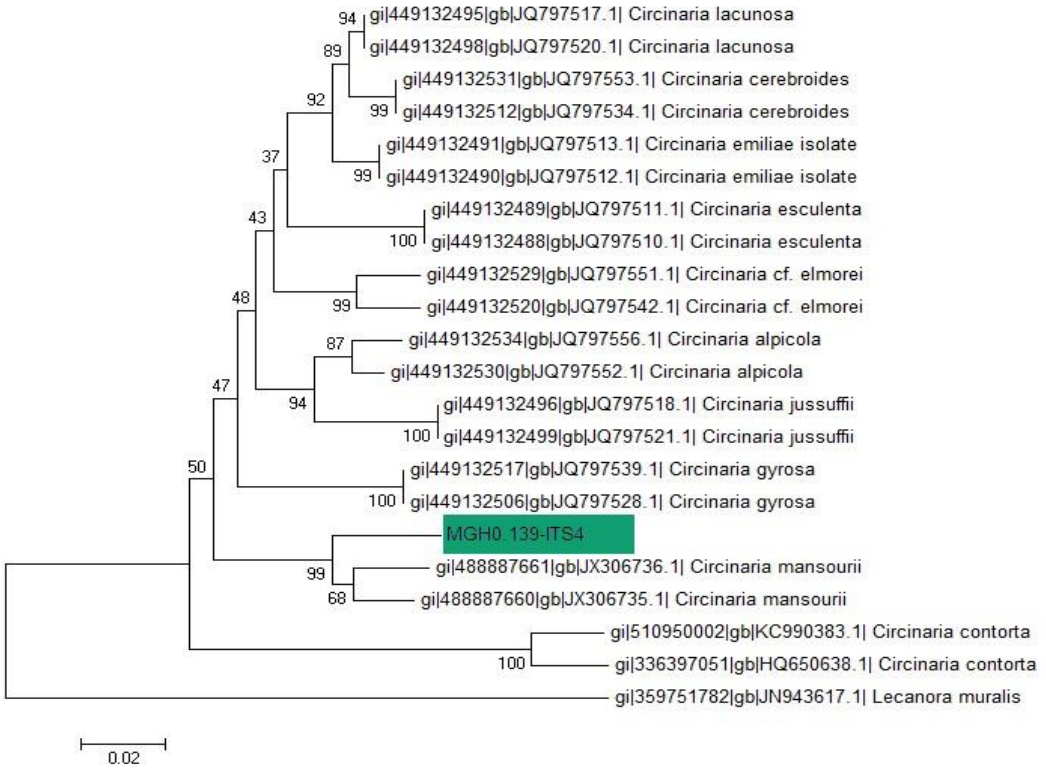


Figure 4. Neighbor-Joining (NJ) dendrogram of *Circinaria contorta* and related species (ERC MGH 0.139)

ERC MGH 0.139 numbered sample is branching with *Circinaria mansourii* in NJ dendrogram (Figure 4). But when we examine the morphology and ecology of this sample; it is obvious that it has quite important differences from *C. mansourii*. While *C. mansourii* has subsquamulose to appressed sub-fruticose thallus attached by tiny rhizomorph-like extensions on perennial grasses (Lumbsch et al. 2011); our sample has obviously crustose thallus growing on siliceous rocks. Besides *C. mansourii* is known to be sterile as no apothecia or pycnidia are known from this species (Lumbsch et al. 2011); but our sample is richly fertile. Because of all these reasons; we classified this sample under the species name *Circinaria contorta*.

**3.3. *Lecanora rupicola*** (L.) Zahlbr. **Figure 5**

**Specimen examined:** Turkey, Kayseri, Talas; Erciyes Mountain, Ali Mountain, 38° 40′ 476″ N, 35° 32′ 993″ E, alt. 1380 m, 06.04.2015 **[ERC MB 0.010]**.

Thallus crustose, cracked-areolate; areoles slightly convex greyish, 3 cm in diam. Apothecia immersed to slightly raised, lecanorine, (0.5–)0.7–*1*–1.3(–1.5) mm in diam. Apothecia disc smooth, gray. Thallus and medulla K+ yellow, C–, KC–, Pd–; Apothecial disc C + vivid yellow. Asci clavate, 8 spored, (51–)52–*56*–60(–62) × (14–)16–*17.5*–19 µm. Ascospores hyaline, simple, (14–)14.5–*15*–15.5(–16) × (7–)7.1–*7.5*–7.9(–8) µm. Hymenium hyaline, (67–)67.5–*78*–88.5(–92) µm. Paraphyses slightly thickened in the apex. Subhymenium hyaline. Hypotecium hyaline.

Circumpolar from temperate to artctic in Northern Hemisphere on hard siliceous rocks from sea level to high altitudes (Purvis 1992). It has a wide distribution in Turkey (e.g. Aslan 2000, Kocakaya et al. 2009).


Figure 5. *Lecanora rupicola* (ERC MB 0.010)

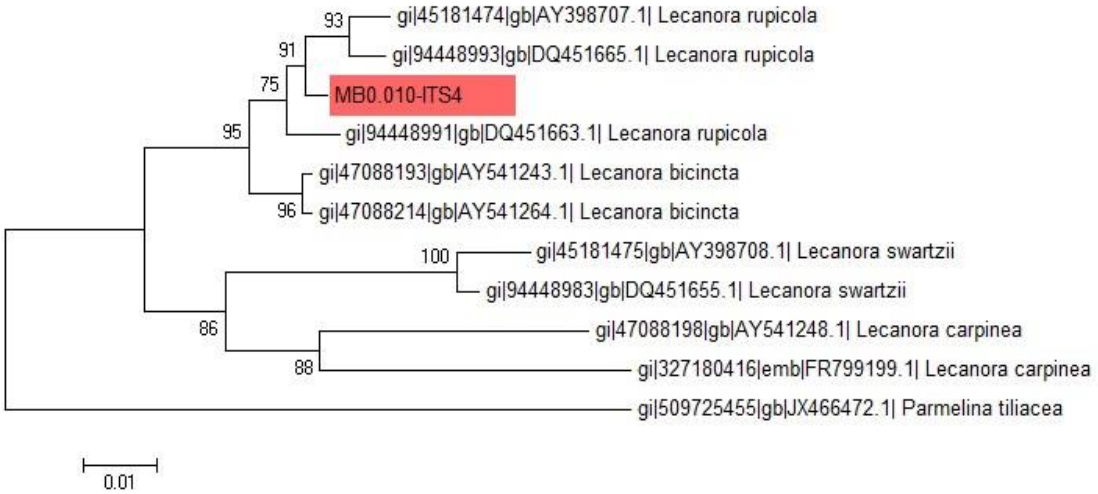


Figure 6. Neighbor-Joining (NJ) dendrogram of *Lecanora rupicola* and related species (ERC MB 0.010)

In the NJ dendrogram (Figure 6); the closest branching to *Lecanora rupicola* is *L. bicincta* Ramond. While *L. rupicola* has sessile to subimmersed apothecia and whitish or grayish pruinose apothecial disc, *L. bicincta* has slightly stalked apothecia and bluish pruinose apothecial disc. In addition, *L. bicincta* has parathecial ring which is black in apothecial discs (Lumbsch & Elix 2004). This parathecial ring is lacking in *L. rupicola*. *L. rupicola* and *L. swartzii* (Ach.) Ach. are similiar species, but *L. swartzii* is reacted with C + vivid yellow to orange and has more convex areoles (Lumbsch & Elix 2004).

**3.4. *Lecidea atrobrunnea*** (DC.) Schaer. **Figure 7**

**Specimen examined:** Turkey, Kayseri, Talas; Erciyes Mountain, Ali Mountain, 38° 40′ 476″ N, 35° 32′ 993″ E, alt. 1380 m, 06.04.2015 **[ERC MB 0.008]**.

Thallus areolate, 5 cm in diam. Areoles flat, irregular, dark brown to pale brown, (0.6–)0.7–*0.8*–0.9(–1.1) mm in diam. Surface brownish and reddish brown. Apothecia black to reddish brown, 1 per areole, (0.2–)0.25–*0.3*–0.35(–0.4) mm in diam. All spot tests negative. Epihymenium brown, 14–*18*–22 µm. Hymenium 92–*115*–138(–140) µm. Asci clavate, (85–)87–*100*–113 × 14–*15*–16(–17) µm. Ascospores not observed.

*Lecidea atrobrunnea* has a wide distribution in the higher altitudes of mountains and alpine zones on siliceous rocks (e.g. John & Breuss 2004, Yazıcı et al. 2011).

Figure 7. *Lecidea atrobrunnea* (ERC MB 0.008)

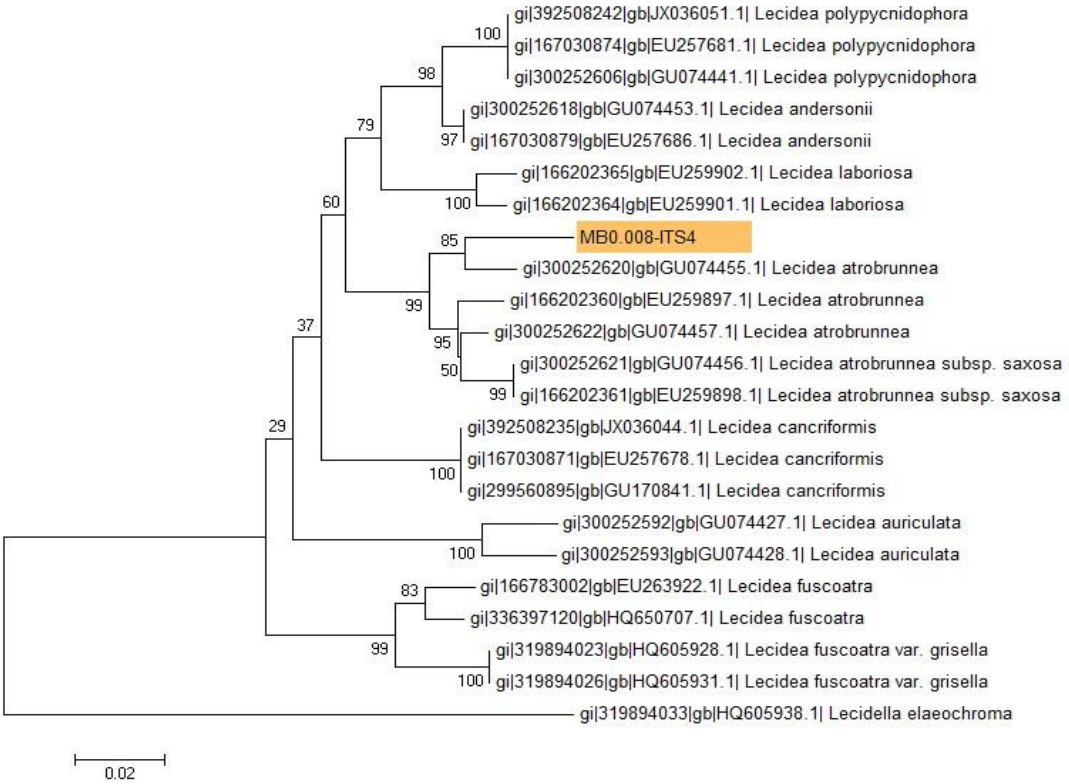


Figure 8. Neighbor-Joining (NJ) dendrogram of *Lecidea atrobrunnea* and related species (ERC MB 0.008)

*Lecidea atrobrunnea* and *L. atrobrunnea* subsp. *saxosa* Hertel & Leuckert are very closely related in the NJ dendrogram (Figure 8). Furthermore, *L. polypycnidophora* U. Rupr. & Türk, *L. andersonii* Filson, *L. laboriosa* Müll. Arg. and *L. cancriformis* C.W. Dodge & G.E. Baker are phylogenetically related with *L. atrobrunnea*. *L. atrobrunnea* differs with 2'-O-methylperlatolic acid from those species (Brodo et al. 2001); besides the latter species are not known from Turkey. *L. atrobrunnea* subsp. *saxosa* includes conorstictic and norstictic acids (Nash 2002). *L. polypycnidophora* includes 4-O-demethylplanaic acid (Ruprecht et al. 2010) and *L. andersonii* includes planaic acid (Ruprecht et al. 2010).

**3.5. *Physcia dubia*** (Hoffm.) Lettau **Figure 9**

**Specimen examined:** Turkey, Kayseri, Erciyes Mountain, Koç Mountain, 38° 42′ N, 35° 32′ E, alt. 2270 m, 16.07.2002 **[ERC MGH 0.025]**.

Thallus irregular, gray or brownish gray, 3─4 cm in diam. Lobe tips often darker, (1.7─)2.2─*2.6*─3(─3.4) × (1─)1.4─*1.8*─2.2(─2.3) cm. Surface gray and cream-colored. Sored present, soralia lip-shaped. Apothecia few and black; semi-immersed, 0.1─*0.7*─1.3(─1.4) mm in diam. Thallus; K+ yellow, C─, KC─, P+ yellow.

It has a wide distribution from temperate regions to boreal regions (Seppelt *et al.* 1996). It grows on acidic roks (e.g. Halıcı & Cansaran-Duman 2007, Candan & Özdemir Türk 2008).

Figure 9. *Physcia dubia* (ERC MGH 0.025)

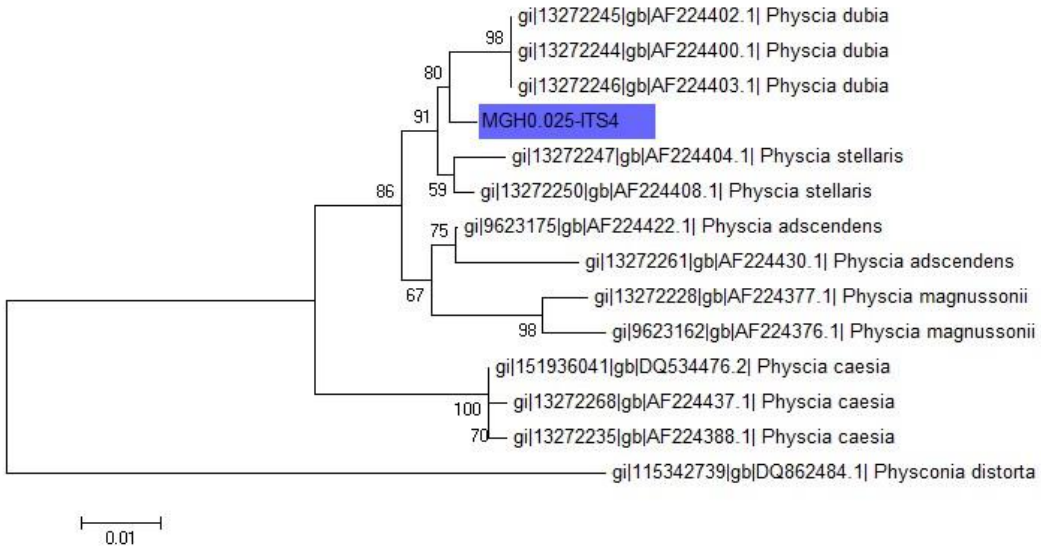


Figure 10. Neighbor-Joining (NJ) dendrogram of *Physcia dubia* and related species (ERC MGH 0.025)

In the NJ dendrogram (Figure 10), the closest branching to *Physcia dubia* is *Physcia stellaris* (L.) Nyl.. While *P. dubia* is sorediate, *P. stellaris* is not sorediate; also *P. dubia* is saxicolous while *P. stellaris* is mostly epiphytic (Brodo & Craig 2003). *P. adscendens* (Fr.) H. Olivier differs from *P. dubia* with helmet shaped soralia (Galloway & Moberg 2005). The other related saxicolous species *P. magnussonii* Frey has numerous apothecia and it is not sorediate. (Moberg & Hansen 1986). *P. dubia* is mostly known to be sterile; but interestingly the population from Erciyes Mountain which we studied was fertile with few apothecia.

**3.6. *Rhizocarpon geographicum*** (L.) DC. **Figure 11**

**Specimen examined:** Turkey, Kayseri, Talas; Erciyes Mountain, Ali Mountain, 38° 40′ 476″ N, 35° 32′ 993″ E, alt. 1380 m, 06.04.2015 **[ERC MB 0.011]**.

Thallus crustose, 4 cm in diam. Areoles scattered, (0.5─)0.8─*1.2*─1.6(─1.9) mm in diam. Prothallus present and black coloured. Areoles greenish yellow. Apothecia black, 0.3─*0.5*─0.7 mm in diam; immersed between areoles. Thallus and medulla K─, C─, KC─, Pd+ yellow. Epihymenium bluish black. Hymenium 29─*68*─107 µm. Paraphyses 3─*3.2*─3.4 µm. Asci dark green to brown, 8 spored. Ascospores muriform and elipsoid, dark brown, (32─)33─*37*─41(─42) × (18─)19─*20*─21(─23) µm.

*Rhizocarpon geographicum* is a cosmopolite species on siliceous rocks (Armstrong 2002, Webber & Andrews 1973). It is also known from almost everywhere in Turkey where siliceous rocks are present (e.g. Yazıcı & Aslan 2003, Tufan et al. 2005).

Figure 11. *Rhizocarpon geographicum* (ERC MB 0.011)

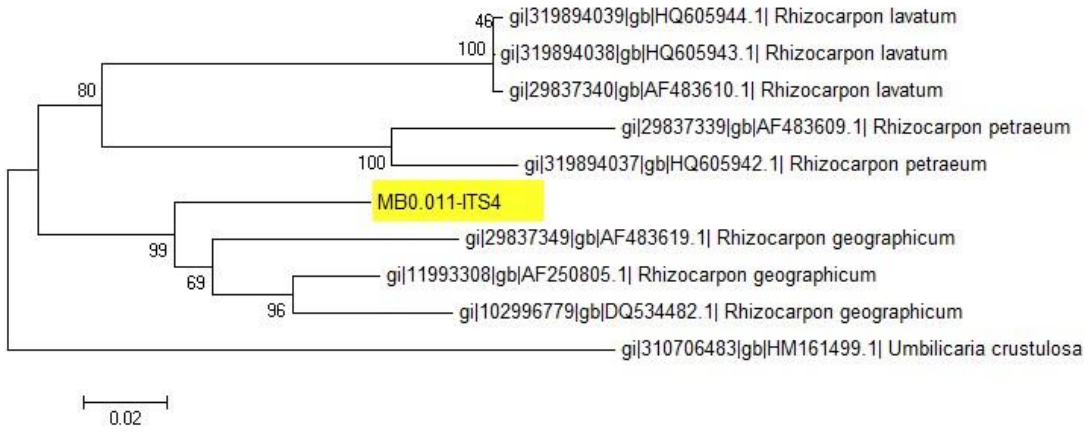


Figure 12. Neighbor-Joining (NJ) dendrogram of *Rhizocarpon geographicum* and related species (ERC MB 0.011)

In the NJ dendrogram (Figure 12); the closest branching to *Rhizocarpon geographicum* is *R. lavatum* (Ach.) Hazsl. *R. geographicum* has a greenish surface color, but *R. lavatum* has a grayish and brownish surface color (Matwiejuk 2010, Joshi et al. 2010). While *R. geographicum* has a hyaline hymenium, other species which have longer than from 34 µm of average ascospore length such as *R. macrosporum* Rasanen have a green hymenium (Moniri et al. 2010).

**3.7. *Rhizoplaca peltata*** (Ramond) Leuckert & Poelt **Figure 13**

**Specimen examined:** Turkey, Kayseri, Talas; Erciyes Mountain, Ali Mountain, 38° 40′ 476″ N, 35° 32′ 993″ E, alt. 1380 m, 06.04.2015 **[ERC MB 0.003]**.

Thallus often lobed, 3 cm in diam. Lobes rolled downward, edges blackened, 2.5─*2.9*─3.3(─3.5) mm in length, 1.5─*2*─2.5 mm in width. Surface greenish yellow. Apothecia yellowish, (0.7─)0.8─*1.4*─2 mm in diam. Thallus and medulla K─, C─, KC─, Pd+ yellow. Hymenium 68─*75*─82 µm. Paraphyses hyaline, simple, 2.7─*3.2*─3.7(─4) µm. Asci clavate, 8 spored, (47─)48─*50*─52 × (15─)16─*17*─18(─19) µm. Ascospores globose, (7─)7.4─*8.2*─9 × (6.5─)7─*7.6*─8.2(─8.5) µm.

It has a distribution in the arid regions. It often grows on vertical surface of rocks (e.g. Pisut 1970, Halıcı & Aksoy 2009). In the NJ dendrogram (Figure 14), the closest branching to *R. peltata* is *R. melanophthalma* (DC.) Leuckert. *R. peltata* contains pannarin, zeorin and norstictic acid in medulla, but R. *melanophthalma* has contain psoromic and lecanoric acid (Arup & Grube 2010). Furthermore, *R. peltata* is distinguished from *R. chrysoleuca* and *R. melanophthalma* with presence of terpenoids and with having a crater-like structure of apothecia (Arup & Grube 2010).

Figure 13. *Rhizoplaca peltata* (ERC MB 0.003)

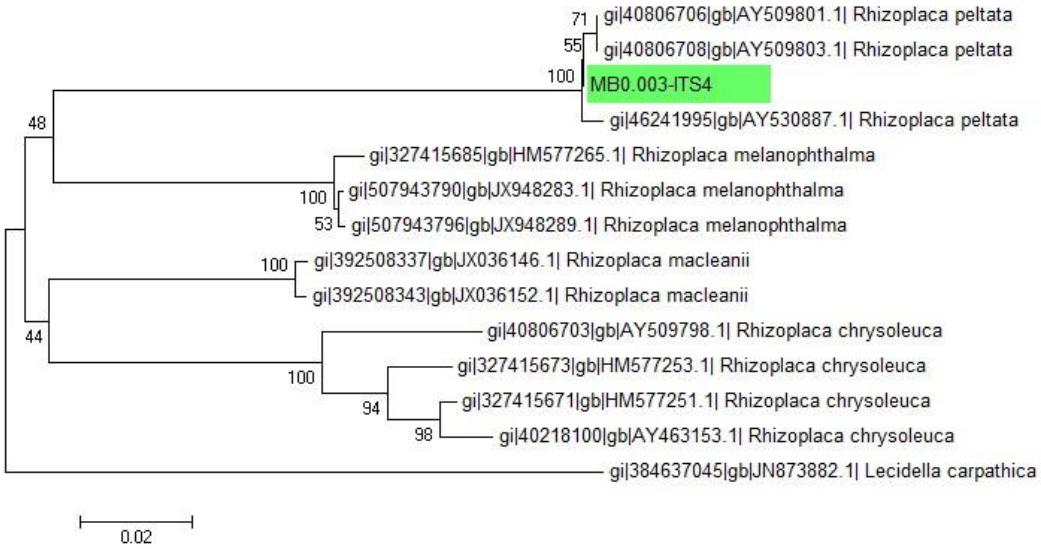


Figure 14. Neighbor-Joining (NJ) dendrogram of *Rhizoplaca peltata* and related species (ERC MB 0.003)

**3.8. *Tephromela atra*** (Huds.) Hafellner **Figure 15**

**Specimen examined:** Turkey, Kayseri, Talas; Erciyes Mountain, Ali Mountain, 38° 40′ 476″ N, 35° 32′ 993″ E, alt. 1380 m, 06.04.2015 **[ERC MB 0.004]**.

Thallus crustose, 5 cm in diam. Areoles usually irregular. Surface grayish-white. Apothecia black, sessile, 1.1─*1.3*─1.5 mm in diam. Thallus and medulla K+ yellow, C─, Pd─. Epihymenium dark reddish coloured. Hymenium purplish or purplish red, 238─*245*─252 µm. Hypotecium 43─*56*─69 µm. Paraphyses branched, (2.8─)2.9─*3*─3.1 µm. Asci clavate, 8 spored, 38─*46*─54 × 15 µm. Ascospores hyaline, simple, (6─)8─*10*─12(─13) × (4─)5.5─*6.7*─7.9(─10) µm. It has a wide distribution from coastal regions to high mountain regions (e.g. Rigler 1852, Güvenç et al. 2006).

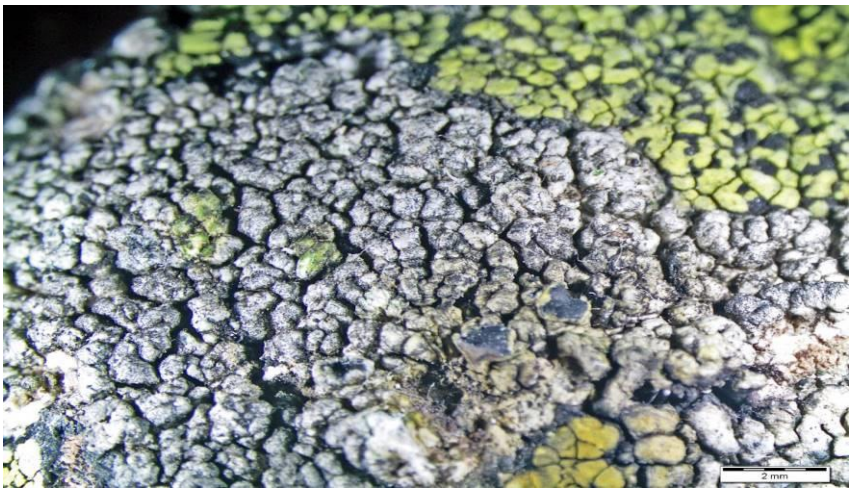

Figure 15. *Tephromela atra* (ERC MB 0.004)

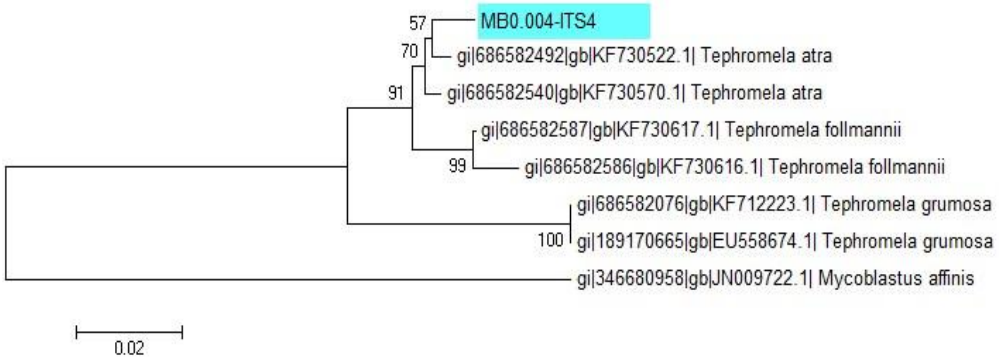


Figure 16. Neighbor-Joining (NJ) dendrogram of *Tephromela atra* and related species (ERC MB 0.004).

In the NJ dendrogram (Figure 16); the closest branching to *Tephromela atra* is *T. follmannii* Pérez-Vargas, Hern.-Padr. & Elix. *T. follmannii* differs from *T. atra* with areolate-bullate to verrucose thallus (Pérez-Vargas et al. 2010). Another species of the genus *T. grumosa* (Pers.) Hafellner & Cl. Roux is sorediate, but *T. atra* is not (Muggia et al. 2008). While *T. atra* includes α-collatolic and α-alectoronic acid, *T. grumosa* includes lichesterinic acid (Westberg et al. 2015, Millot et al. 2008, Hesbacher et al. 1996). *T. atra* is very similar morphologically with *Lecanora gangaleoides* but it can be easily distinguished with its purple hymenium (Millot et al. 2008).

**3.9. *Xanthoparmelia pulla*** (Ach.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch **Figure 17**

**Specimen examined:** Turkey, Kayseri, Talas; Erciyes Mountain, Ali Mountain, 38° 40′ 476″ N, 35° 32′ 993″ E, alt. 1380 m, 06.04.2015 **[ERC MB 0.001]**.

Thallus foliose, 6 cm in diam. Surface dark green and brownish green. Lobes (6─)6.1─*6.3*─6.5 × 3.4─*3.5*─3.6 mm. Apothecia absent. All spot tests negative.

It has a wide distribution in Africa, Australia, New Zealand and Europe. It is mostly found on siliceous soil and siliceous, acidic and volcanic rocks (e.g. Nimis & John 1998, Kınalıoğlu & Aptroot 2012).

Figure 17. *Xanthoparmelia pulla* (ERC MB 0.001)

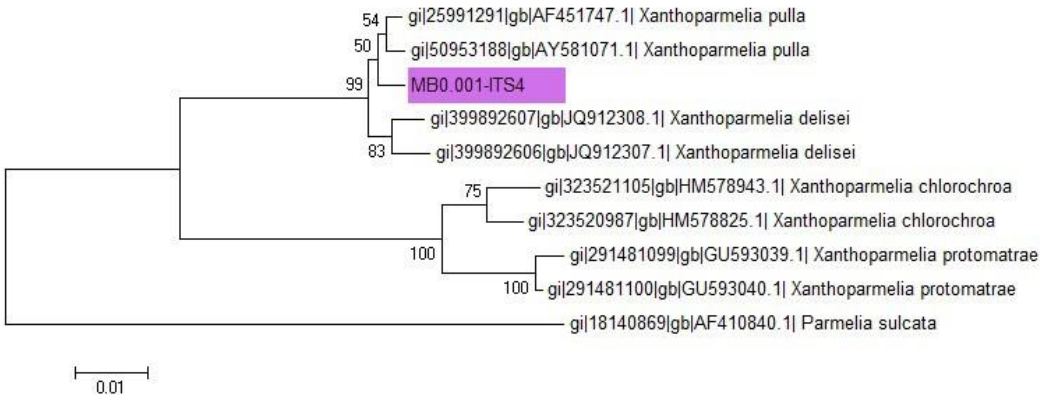


Figure 18. Neighbor-Joining (NJ) dendrogram of *Xanthoparmelia pulla* and related species (ERC MB 0.001)

In the NJ dendrogram (Figure 18); the closest branching to *X. pulla* is *X. delisei* (Duby) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch. Morphologically these two species are very similar to each other but *X. delisei*

contains glomelliferic and glomellic acides (de Paz et al. 2012, Szczepańska & Kossowska 2014). Other related species *X. protomatrae* contains fumarprotocetraric acid (Giordani et al. 2002), but *X. pulla* contains stenosporic, divaricatic and 4-O-demethylstenosporic acid (de Paz et al. 2012, Szczepańska & Kossowska 2014).

## 4. Conclusions and discussion

In this study, the ITS sequences of 9 common lichenized fungi species (*Aspicilia cinerea*, *Circinaria contorta*, *Lecidea atrobrunnea*, *Lecanora rupicola*, *Physcia dubia*, *Rhizoplaca peltata*, *Rhizocarpon geographicum*, *Tephromela atra* and *Xanthoparmelia pulla*) which has a wide distribution in the alpine zones of volcanic Erciyes Mountain in Central Anatolia are provided. Sometimes morphological characters used in lichen classification lead to misidentifications. Because of this, it is also important to make molecular studies in lichen taxonomy. Those ITS sequences provided for this study are now in GenBank and can be used in the future phylogenetic studies of lichens..

**References**


Armstrong, R. A. 2002. The effect of rock surface aspect on growth, size structure and competition in the lichen *Rhizocarpon geographicum*. Environmental and Experimental Botany. 48/2. 187-194.

Arup, U., Grube, M. 2000. Is *Rhizoplaca* (Lecanorales, lichenized Ascomycota) a monophyletic genus. Canadian Journal of Botany. 78/3. 318-327.

Arup, U., Søchting, U., Frödén, P. 2013. A new taxonomy of the family Teloschistaceae. Nordic Journal of Botany. 31/1. 16-83.

Aslan, A. 2000. Lichens from the regions of Artvin, Erzurum, and Kars (Turkey). Israel Journal of Plant Sciences. 48/2. 143-155.

Brodo, I. M., Sharnoff, S. D., Sharnoff, S. 2001. Lichens of North America. Yale University Press. New Haven. USA.

Brodo, I. M., Craig, B. 2003. Identifying Mixed Hardwood Forest Lichens, A Reference Notebook. Environment Canada, Canada Centre for Inland Waters, Burlington, Ontario, Canada.

Candan, M., Özdemir Türk, A. 2008. Lichens of Malatya, Elazığ and Adıyaman provinces (Turkey). Mycotaxon. 105. 19-22.

Çobanoğlu, G., Açıkgöz, B., Baloniu, L. 2013. Contributions to lichen diversity of Turkey from the Sarısu area (Kocaeli). Turkish Journal of Botany. 37. 964-969.

De Paz, G. A., Cubas, P., Crespo, A., Elix, J. A., Lumbsch, H. T. 2012. Transoceanic dispersal and subsequent diversification on separate continents shaped diversity of the *Xanthoparmelia pulla* group (Ascomycota). PloS one, 7/6. e39683.

Fryday, A., Coppins, B. 1997. Keys to sterile, crustose saxicolous and terricolous lichens occurring in the British Isles. The Lichenologist. 29/4. 301-332.

Galloway, D. J., Moberg, R. 2005. The lichen genus *Physcia* (Schreb.) Michx.(Physciaceae: Ascomycota) in New Zealand. Tuhinga. 16. 59-91.

Giordani, P., Nicora, P., Rellini, I., Brunialti, G., Elix, J. A. 2002. The lichen genus *Xanthoparmelia* (Ascomycotina, Parmeliaceae) in Italy. The Lichenologist. 34/3. 189-198.

Guzow, B., Gamiak, MK., Wegrzyn, G. 2001. Moleculer determination keys: construction of keys for species identification based on restriction fragment length polymorphism. International Archives of Bioscience. 1. 1057-1067.

Güvenç, S. 2001. Some lichen records from Kayseri province. Ot Sistematik Botanik Dergisi 8/2. 143–150.

Güvenç, Ş., Öztürk, Ş., Aydın, S. 2006. Contributions to the lichen flora of Kastamonu and Sinop Provinces in Turkey. Nova Hedwigia. 83/1-2. 67-98.

Halıcı, M. G., John, V. Aksoy, A. 2005. Lichens of Erciyes Mountain (Kayseri, Turkey). Flora Mediterranea. 15. 567-580.

Halıcı, M. G., Kocakaya, M., Aksoy, A. 2006. Additional and Interesting Lichenized and Lichenicolous Fungi From Turkey. Mycotaxon, 96. 13-19.

Halıcı, M. G., Hawksworth, D.L., Aksoy, A. 2007. New and interesting lichenicolous fungi records from Turkey. Nova Hedwigia. 85. 393-401.

Halıcı, M. G., Cansaran Duman, D. 2007. Lichenized and lichenicolous fungi of Yaylacık (Bolu) and Yenice (Karabük) research forests in Turkey. Mycologica Balcanica. 4. 97-103.

Halıcı, M. G., Güvenç, Ş. 2008. Lichens from Mediterranean Region of Turkey. Cryptogamiae Mycol. 29. 95–106.

Halıcı, M. G., Aksoy, A. 2009. Lichenised and Lichenicolous Fungi of Aladağlar National Park (Niğde, Kayseri and Adana Provinces) in Turkey. Turkish Journal of Botany. 33/3. 169-189.

Halıcı, M. G., Candan, M., Güllü, M. 2014. *Phoma recepii* sp. nov. from the Caloplaca cerina group in Turkey. Mycotaxon, 129/1. 163-168.

Hesbacher, S., Fröberg, L., Baur, A., Baur, B., Proksch, P. 1996. Chemical variation within and between individuals of the lichenized ascomycete *Tephromela atra*. Biochemical systematics and ecology. 24/7. 603-609.

John, V. 2002. Lichenes Anatolici Exsiccati. Fasc. 6-7. Arnoldia. 21. 1-28.

John, V., Breuss, O. 2004. Flechten der östlichen Schwarzmeer-Region in der Türkei (BLAM-Exkursion 1997). Herzogia. 17. 137-156.

Joshi, Y., Koh, Y. J., Hur, J. S. 2010. Three new records of lichen genus *Rhizocarpon* from South Korea. Mycobiology. 38/3. 219-221.

Kınalıoğlu, K., Aptroot, A. 2012. Some Lichens From Afyonkarahisar and Kırıkkale Provinces. Gazi University Journal of Science. 25/2. 301-306.

Kocakaya, M., Halıcı, M. G., Aksoy, A. 2009. Lichens and lichenicolous fungi of Kızıldağ (Derebucak, Konya). Turkish Journal of Botany. 33/2. 105-112.

Lumbsch, H. T., Elix, J. A. 2004. Lecanora. In Flora of Australia. Volume 56A, Lichens. 4. 12–62.

Matwiejuk, A. 2012. *Rhizocarpon lavatum* and *R. reductum* (Rhizocarpaceae, Ascomycota), two misunderstood taxa found in the Gorce Mts (Polish Carpathians). Acta Mycologica. 47/1. 121-126.
Millot, M., Tomasi, S., Sinbandhit, S., Boustie, J. 2008. Phytochemical investigation of *Tephromela atra*: NMR studies of collatolic acid derivatives. Phytochemistry Letters. 1/3. 139-143.
Moberg, R., Hansen, E. S. 1986. The lichen genus *Physcia* and allied genera in Greenland. Bioscience. 22. 3-11.
Moniri, M. H., Kamyabi, S., Clayden, S. R. 2010. A preliminary study of *Rhizocarpon macrosporum* in Razavi Khorasan Province (NE Iran). The Iranian Journal of Botany. 16/1. 185-189.
Muggia, L., Grube, M., Tretiach, M. 2008. Genetic diversity and photobiont associations in selected taxa of the *Tephromela atra* group (Lecanorales, lichenised Ascomycota). Mycological Progress 7/3. 147-160.
Nash, T. H. 2002. Lichen flora of the greater Sonoran desert region. Lichens Unlimited. Arizona State University. Arizona. USA.
Nimis, P. L., John, V. 1998. A contribution to the lichen flora of Mediterranean Turkey. Cryptogamie. Bryologie, lichénologie. 19/1. 35-58.
Nordin, A., Tibell, L. Owe-Larsson, B. 2007. A preliminary phylogeny of *Aspicilia* in relation to morphological and secondary product variation. In: Lichenologische Nebenstunden: Contributions to lichen taxonomy and ecology in honour of Klaus Kalb. 247-266.
Oran, S., Uğur, A., Öztürk, Ş. 2007. Some Lichen Records From Quercus vulcanica Forests Around Yukarı Gökdere (Isparta, Turkey). J. Biol. Environ. Sci. 1/3. 121-126.
Pérez-Vargas, I., Padrón, C. H., de Paz, P., Pedro, L., Elix, J. A. 2010. *Tephromela follmannii* (lichenized Ascomycota), a new species from the Canary Islands. Mycotaxon. 112/1. 9-14.
Pisut, I., 1970. Interessante flechtenfunde aus der Türkei. Preslia (Praha). 42. 379-383.
Purvis, O. W. 1992. Lichen Flora of Great Britain and Ireland. Natural History Museum Publications in association with the British Lichen Society.
Rigler, L. 1852. Die Türkei und deren Bewohner, in ihren naturhistorischen, physiologischen und pathologischen Verthältnissen vom Standpunkte Constantinopel's. Wien 1: 110.
Roux, C. 2012. Liste des lichens et champignons lichénicoles de France. Bull. Soc. Linn. Provence. 16/3. 3-220.
Ruprecht, U., Lumbsch, H. T., Brunauer, G., Green, T. G., Türk, R. 2010. Diversity of *Lecidea* (Lecideaceae, Ascomycota) species revealed by molecular data and morphological characters. Antarctic Science. 22/06. 727-741.
Seppelt, R. D., Green, T. G. A., Schroeter, B. 1996. Additions and corrections to the lichen flora of the Kar Plateau, Southern Victoria Land, Antarctica. New Zealand Journal of Botany. 34/3. 329-331.
Steiner, J. 1905. Lichenes. In: Ergebnisse einer naturwissensch. Reise zum Erschias-Dagh (Kleinasien) von Dr. Arnold Penter und dr. Emerich Zederbauer im Jahre 1902. Ann. Naturhistorisches Museum Wien 20/4. 369-384.
Szczepanska, K., Kossowska, M. 2014. The lichen-forming fungi of the *Xanthoparmelia pulla* group (Parmeliaceae, Ascomycota) in Poland. Acta Societatis Botanicorum Poloniae. 83/1. 59-65.
Tamura, K., Stecher, G., Peterson, D., Filipski, A., Kumar, S. 2013. MEGA6: molecular evolutionary genetics analysis version 6.0. Molecular biology and evolution, 30/12. 2725-2729.
Tufan, O., Sumbul, H., Turk, A. O. 2005. The lichen flora of the Termessos National Park in Southwestern Turkey. Mycotaxon. 94. 43-46.
Türk, A. Ö., Halıcı, M. G., Candan, M., Yavuz, Y. 2015. The lichenized fungus genus Peltigera in Turkey. Biodicon. 8/2. 146-156.
Webber, P. J., Andrews, J. T. 1973. Lichenometry: a commentary. Arctic and Alpine Research. 5/4. 295-302.
Westberg, M., Timdal, E., Asplund, J., Bendiksby, M., Haugan, R., Jonsson, F., Millanes, A. 2015. New records of lichenized and lichenicolous fungi in Scandinavia. MycoKeys. 11. 33-61.
Vondrák, J., Halıcı, MG., Güllü, M., Demirel, R. 2016. Taxonomy of the genus Athallia and its diversity in Turkey. Turkish Journal of Botany. 40/3. 319-328.
Yazıcı, K., ASLAN, A. 2003. Lichens from the regions of Gümüşhane, Erzincan and Bayburt (Turkey). Cryptogamie. Mycologie. 24/3. 287-300.
Yazıcı, K., Etayo, J., Aslan, A. 2011. A note about lichenicolous fungi from Ardahan (Turkey). Cryptogamie, Mycologie. 32/4. 429-437.

*(Received for publication 21 December 2015; The date of publication 15 August 2016)*