

**T.C.  
ERCIYES UNIVERSITY  
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCE  
DEPARTMENT OF BIOLOGY**

**DETERMINATION OF LICHENIZED FUNGAL MYCOTA OF  
GÖKÇEADA (ÇANAKKALE, TURKEY) BY THE AID OF DNA  
BARCODING METHODS**

**Marwan Aed KHALAF**

**Supervisor  
Prof. Dr. Mehmet Gökhan HALICI**

**Phd. Thesis**

**August 2022**

**KAYSERİ**



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### **COMPLIANCE WITH SCIENTIFIC ETHICS**

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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Kayseri, August 2022

# DNA BARKODLAMA METODU YARDIMIYLA GÖKÇEADA (ÇANAKKALE, TÜRKİYE)'NİN LİKENLEŞMİŞ MANTAR MİKOTA'SININ BELİRLENMESİ

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## KISA ÖZET

Çanakkale (Gökçeada)'den toplanan liken örnekleri öncelikle morfolojik, anatomik ve ekolojik özellikleri göz önüne alınarak değerlendirildi. Bu örneklerden bazılarının ITS gen bölgeleri analiz edildi, filogenetik ağaçlar kuruldu. Türlerin lokalite ve ekoloji bilgileri, deskripsiyonları belirlendi. Bu çalışma sonucunda arazi bölgesinden toplam 40 likenleşmiş mantar türü belirlenmiştir. Moleküler incelemeler PZR yardımıyla ITS primeri kullanılarak gerçekleştirilmiştir. Sekans analizleri ile ilgili bölgeler incelenmiştir. ITS sekansları için filogenetik analizler ve dendogramlar, çalışılan örnekler ve gen bankasından alınan örneklerle birlikte yapılmıştır. Filogenetik analizler Neighbour joining (NJ) metodu ile gerçekleştirilmiştir. Bu doktora tezi kapsamında yapılan çalışmalar sonucunda, *Polyozosia schofieldii* (Brodo) S.Y. Kondr., Lőkös & Farkas, *Rhizocarpon atroflavescens* Lyngv ve *Toninia talparum* Timdal türleri Türkiye'den ilk kez rapor edildi. *Circinaria mansourii* (Sohrabi) Sohrabi ve *Lecidella flavosorediata* (Vězda) Hertel & Leuckert türleri de ikinci kez Türkiye'den rapor edilmiştir. Bu tez çalışması Gökçeada'nın (Çanakkale) liken biyoçeşitliliğinin ortaya çıkartılmasına yardımcı olacaktır.

**Anahtar Kelimeler:** Filogenetik, Gökçeada, ITS, Biyoçeşitlilik.

**DETERMINATION OF LICHENIZED FUNGAL MYCOTA OF GÖKÇEADA  
(ÇANAKKALE, TURKEY) BY THE AID OF DNA BARCODING METHODS**

**Marwan Aed KHALAF**

**Erciyes University, Graduate School of Natural and Applied Sciences**

**Phd. Thesis, August 2022**

**Supervisor: Prof. Dr. Mehmet Gökhan HALICI**

**ABSTRACT**

Lichen samples collected from Gökçeada (Çanakkale) were evaluated primarily by considering their morphological, anatomical and ecological characteristics. ITS gene regions of some of these samples were analyzed and phylogenetic trees were established. The locality and ecology information and descriptions of the species were determined. As a result of this study, a total of 40 lichenified fungi species were determined from the study area. Molecular analyzes were performed using ITS primer with the help of PCR. Regions related to sequence analysis were examined. Phylogenetic analyzes and dendograms for ITS sequences were performed with studied samples and samples from the gene bank. Phylogenetic analyzes were performed using the Neighbor joining (NJ) method. As a result of the studies carried out within the scope of this doctoral thesis, *Polyozosia schofieldii* (Brodo) S.Y. Kondr., Lőkös & Farkas, *Rhizocarpon atroflavescens* Lyngv and *Toninia talparum* Timdal species were also reported from Turkey for the first time. *Circinaria mansourii* (Sohrabi) Sohrabi and *Lecidella flavosorediata* (Vězda) Hertel & Leuckert species were also reported from Turkey for the second time. This thesis will help to reveal the lichen biodiversity of Gökçeada (Çanakkale).

**Keywords:** Phylogenetics, Gökçeada, ITS, Biodiversity.

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## INTRODUCTION

Lichens are known as a classic example of mutualistic symbiosis and are defined as the relationship between a fungal partner (mycobiont) and at least one photosynthetic partner (photobiont), an algae or cyanobacteria [1]. However, a recent study also reported that lichens also contain basidiomycetes yeasts as an additional fungal partner in addition to the fungus and algae/cyanobacteria partner [2].

In the association of mycobiont and photobiont, mycobiont lichens are the dominant organisms of lichens. Lichens are classified in the fungal kingdom, and the scientific names of lichens are actually the names of mycobionts. Lichens produce secondary compounds and these compounds can be used in many fields such as medicine and pharmacy. Lichens are also used as biological indicators of air pollution. Due to the advantages of symbiotic life, lichens can be found almost everywhere from human-destroyed areas to natural forests and even from the poles to deserts [3,4].

There are many fields of study required to carry out studies on lichen biodiversity in Turkey. Revision studies on lichen species continue to increase day by day. As the number of people working on lichens increases and more specific studies focusing on genera increase, the lichen biodiversity of Turkey will be able to be revealed accurately and in more detail.

Systematic studies on lichens; As in other organisms, it is made according to morphological, anatomical and ecological characters. However, secondary metabolites found in lichen thalli interact with certain chemicals, causing color formation, and in this case, help identify lichens. In order to more accurately determine the lichen acids contained in the species, chromatographic methods such as TLC, HPLC and HPTLC are used. In addition to all these morphological, anatomical, ecological and chemical studies, it is possible to reach more precise results by doing molecular studies.

Scientists working on lichens classify lichens with different methods. Taxonomic studies on lichens are generally carried out according to morphological and chemotaxonomic methods. However, taxonomic studies alone may not be sufficient to determine the systematic categories of lichens. There are differences in the morphology and chemical composition of lichens in different habitats. Some species complexes have different relationships with different photosynthetic organisms under different environmental conditions. Individuals of the same species living in different habitats may differ in appearance, but genetic structures do not change easily. Because genotype is more stable than phenotype, genetic traits help confirm morphological or anatomical traits in taxonomic studies. For these reasons, the use of molecular techniques in addition to taxonomic studies has been increasing in recent years [2,5-9].

Studies that helped ensure morphological and anatomical features in lichens were few before the development of the PCR technique based on molecular biology techniques. With the initiation of PCR applications, nucleic acids were used to identify new characters. Today, PCR is an important method in molecular biological studies of population genetics and fungal phylogeny [10].

Molecular studies in lichens are based on the rDNA ITS gene region. Because the ITS gene region is a rapidly evolving region, it is often used to study organisms at the genus, species, and even population level. However, sometimes it may not be enough to distinguish the ITS gene region on the phylogenetic tree correctly. Therefore, studying different gene regions is more useful in determining the accuracy of species.

In this thesis, it is aimed to determine the taxonomic characteristics of lichenized fungi species distributed in Çanakkale (Gökçeada), to evaluate morphological and anatomical studies together with sequence analyzes obtained as a result of molecular studies, and to find new records and new species within the scope of these studies.

## CHAPTER 1

### GENERAL INFORMATION

Lichens are symbiotic organisms formed by the combination of two completely different organisms, a fungus and one or more algae [11]. Lichen has a completely independent appearance from the fungus and algae in its structure; it resembles neither fungus nor algae. Lichens, consisting of a union of fungi and algae, are the smallest ecosystems that constitute the most perfect example of symbiotic relationship [12].

B.C. In the 4th century, the Greek scientist Theophrastus used the term 'Lichen' for the first time, but he named liverworts as lichens. The term true lichen was used by Schwendener (Swedish botanist) in 1867 to express the thallus structure consisting of fungi and algae. This view was not accepted by the important scientists of the time, but later it was universally accepted that the lichen thallus was in a symbiotic relationship [13].

Lichens are morphologically divided into three main groups: crust-like (crustose), leafy-like (foliose) and branchy or fruticose. Besides these main groups, there are many intermediate forms. In the structure of the placoid thallus, the central part is crustal, while the marginal parts are in the form of lobes; Again, the clustered areoles of crusty lichens become thin, small lobes and form the scaly thallus structure. The difference between lichens with supfoliose thallus and leafy lichens is that their rhizins are only in the central part. Also, some types of lichens (like *Cladonia*) consist of more than one growth form. The primary thallus may be permanent or disappear later, and the secondary thallus may form a scaly structure or a branchy structure that grows vertically upwards, or a structure called potassium, whose ends are developed like a goblet [13].

Lichens can be in many different colors, from white to gray, yellow to orange or green, brown to black. This color diversity of lichens occurs as a result of the differences in the algal partner, lichen acids, amorphous substances, pigments and lichen chemical substances in their structures. The amount of lichen chemicals varies depending on the amount of light in the shade and in sunny environments (Figure 1.1.). This change also causes color change in lichen thallus [14].



A. Sunlit, open field thallus

B. Thallus in the shade area

**Figure 1.1.** Color change of *Xanthoria parietina* species depending on the amount of light (A) Orange-yellow thallus in bright conditions (B) Green-yellow thallus in shady conditions.

Lichens do not have a specific reproductive system, as they consist of the organization of two different organisms. They reproduce by apothecia or perithecia, which are sexual reproductive structures and spore-producing, or by structures called soredia and izidia, formed by the participation of fungi and algae, or by vegetative reproduction from broken thallus pieces. Algae, which are photosynthetic partners, do not form genitalia in the lichen thallus and reproduce only vegetatively [14,15]

While the lichen mycobiont ensures reproduction, the photobiont provides the carbohydrates necessary for both itself and its mycobiont partner. The type of carbohydrate produced and delivered to the fungus differs according to the type of photobiont. While glucose is formed in lichens containing blue-green bacteria, sugar

alcohols such as erythritol, sorbitol or ribitol are formed and transferred to the mycobiont in lichens containing green algae [14,15].

Lichens are ecologically very important symbiotic organisms. By forming a colony on the surface of the rocks, they cause the rock to be eroded and cracked, thus forming soil [11]. Thus, the first stage of succession is created and the necessary environment is provided for the mosses to settle. In the continuation of the mosses, a habitat is prepared for more developed terrestrial plants suitable for environmental conditions [16].

### **1.1. Molecular Classification of Lichens**

Traditional taxonomy is mostly based on the morphological and anatomical features of organisms. However, the rapid development of molecular biology techniques has affected all biological disciplines, including taxonomy. Traditional diagnostic keys operate on the morphological, anatomical, and rarely chemical characteristics of organisms. However, it is sometimes difficult to classify the studied organisms because their characteristics are very close to each other. Morphological and anatomical differences between different species are not sufficient for definitive identification of organisms. In another case, quite a lot of changes occur in organisms living in different habitats, so that organisms belonging to the same species show different morphological and anatomical features. Environmental conditions have an effect on the structure of the genome in natural habitats. Therefore, the genotype; it is more stable than phenotype and genetic traits are in taxonomy; helps to confirm morphological or anatomical features [3].

Systematic studies on lichens; As in other organisms, it is classically based more on morphological characterization. The color reactions of the lichen acids they contain in the thalli of lichens by reacting with certain chemical substances are a helpful factor in their identification. However, these identification studies are not sufficient to determine the systematic categories of lichens [4].

It was little before the development of the PCR technique, which was based on molecular biological techniques that gave precision to lichen systematics. With the initiation of PCR applications, nucleic fragments were used to identify new characters. Today, PCR is an important method in studies of population genetics and molecular biology of fungal phylogeny [5].

Today, an increase in gene regions has been observed in conjunction with detailed multi-locus phylogeny studies of the fungal kingdom. There is a lack of information in detecting relationships among fungi, as studies are currently insufficient. It is estimated that these existing deficiencies will be eliminated by molecular phylogenetic studies [11]. ITS regions are used safely in phylogenetic studies on the basis of species and genus. ITS is very advantageous because rDNA has too many protective (conservative) genes and ITS regions are located between gene regions [17].

rDNA is found on genomic DNA. The parts on the rDNA are in the form of sequentially repetitive gene sequences. The repetitive parts on rDNA consist of the small subunit 18S, 5.8S, and the large subunit 28S genes that encode rDNA. These subunits are located in NOR regions (Nucleolar Organizer Region) in genomic DNA. ITS regions are also located within these rDNA repeats on genomic DNA. The binding sites of ITS primers on rDNA are shown in (Figure 1.2.). [17].

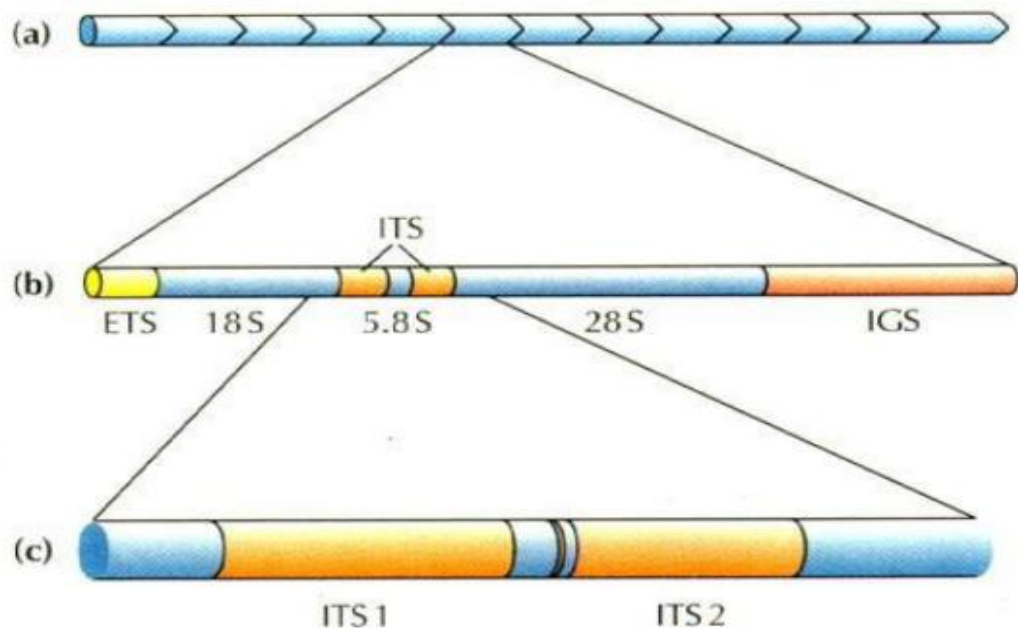


**Figure 1.2.** a-) Gene, b-) rDNA, c-) Binding sites of ITS primers on rDNA [17].

rDNA genes are separated from each other by ITS non-transcribed regions (IGS). Adjacent rDNA repeat units include IGS regions (ETS and NTS). ETS is the outer transcription region encoded by ribosomal mRNA and carries its promoter region. NTS (Non Transcribed Spacer) regions between repeat units are non-coding regions [18].

The fungi-specific primer, ITS1F, is located at the 3rd end of the SSU gene of rDNA. This universally accepted primer is complementary to the 5' end of the LSU gene [19].

It has been observed that lichen systematics has been examined at the molecular level with the PCR method and progress has been achieved. Currently, it is seen that the PCR method is used as an important method in molecular studies of fungal phylogeny [20].

PCR is an enzymatic amplification technique using appropriate primers in vitro to amplify DNA sequences [21]. Replication processes are carried out with advanced devices at appropriate temperatures. Numerous copies of the DNA fragment are produced and stained with a small template DNA. They can then be easily detected on advanced devices [22].

Oligonucleotides, called primers, with a length of 10-25 base pairs, are used in PCR markers. Today, different markers have been developed with various primers and primer combinations. ITS primers used on all breeds and the use of breed-specific primers have also started to give reliable results [23-30].

Nucleotides are determined by DNA sequence analysis method. After the 3D structure of the DNA molecule was completed in 1953, RNA fragments were studied in the first attempts to start the sequence analysis studies, and the sequence analysis of the tRNA molecule was performed by Robert Holley in 1965. Two different sequence analysis methods were found in 1977 by Maxam-Walter Gilbert and Sanger. Thus, sequence analysis techniques began to be developed [31].

Phylogenetics is the branch of science that studies evolutionary relationships and kinship, and studies genetic relationships between species. Assuming that organisms with morphological and genetic characteristics are genetically close to each other, the relationship between them is evaluated. Today, the concept of molecular phylogenetics is used to analyze interspecies relationships with molecular data, including DNA and protein sequences.

Genomes evolve by the accumulation of mutations. In this way, it is possible to determine evolutionary relatedness between species by comparing different genomes. Phylogenetic dendograms also show this relationship visually [32].

Phylogenetic trees are constructed based on two different methods. These methods are character-based methods and distance-based methods. Character-based methods are also applied; it is a technique of counting mutations that replicate in sequences. It is made based on different characters, these characters are indicated as the molecular sequences of the living thing in each taxon. In distance-based methods; it is used to calculate the evolutionary distances obtained as a result of alignment of the sequences and to construct the matrix of the distances between each pair of taxa. In the genetic distance method, phylogenetic trees are created based on the number of changes between pairs in the sequence group. When creating a tree, the species with the least genetic distance from each other are combined. These sequence pairs with few nucleotide changes between them are called neighbors. When constructing the tree, the amount of differences between the aligned sequences is determined using distance methods. The number of changes that appear in the branches in the tree indicates the distance between the sequences [33]. The tree that minimizes the distance between taxa is generally the preferred tree [34,35]. These methods are faster and easier than the other methods and can be used for a large number of sequences. The most used among these are the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) and the Neighbor Joining (NJ) method.

## **1.2. Systematic and molecular studies on lichens**

Theell et al. (2002) determined the phylogeny of cetraroid lichens belonging to the Parmeliaceae family, together with ITS and  $\beta$ -tubulin sequence analysis, as well as morphological, anatomical features and identification of secondary metabolites [36].

Lohtander et al. (2009), *Physcia aipolia* and *Physcia caesia* lichen groups used ITS, mtSSU and  $\beta$  Tubulin gene regions to study molecularly. They carried out molecular analyzes of 52 samples belonging to this lichen group [37].

Schmull et al. (2011) investigated the phylogenetic relationships of lichen-forming fungi belonging to the genus *Lecidea* by analyzing the mtSSU, nucLSU, nucSSU, ITS, RPB1 and RPB2 gene regions [38].

Halici et al. (2014) gave a list of the Teloschistaceae (lichenified Ascomycetes) family in Turkey. At the end of the study, the identifications of all listed lichens were supported by ITS nrDNA sequences. *Calogaya arnoldii*, *Caloplaca fuscoatroides*,

*Caloplaca aff. monacensis*, *Caloplaca xerica*, *Flavoplaca cf. havaasii*, *Rufoplaca arenaria s.lat.*, *Variospora australis*, *V. glomerata* and *Xanthocarpia lactea* (Teloschistaceae) species were detected [39].

Vondrak et al. (2016) conducted a study to present the taxonomy of the genus *Athallia* and its diversity in Turkey. They used molecular analyzes of ITS nrDNA using 42 novel and 56 GenBank sequences, revealing 12 supplemented *Athallia* lineages compatible with the phenotype data. At the end of the study, they showed the taxonomy of the genus *Athallia* and its diversity in Turkey [40].

Molecular studies on lichens in Turkey have started to increase in recent years. Firstly, Aras and Cansaran (2006) developed a DNA isolation protocol for lichens by using lichens as herbarium material [41]. Cansaran et al. (2006) determined the phylogenetic affinity of some *Rhizoplaca* species collected from Anatolia by rDNA ITS region sequence analysis [42]. Aras et al. (2007) examined the genetic affinities of some species belonging to the genus *Aspicilia* collected from different regions of Anatolia [43]. Arocena et al. (2007) conducted research on lichens using molecular techniques to determine the effect of lichens on the transformation of minerals in the Mediterranean region [44]. Arup et al. (2015) described the species *Parvoplaca nigroblastidiata* from Sweden, Turkey and Alaska by sequence analysis of the ITS gene region [45].

Until now, there are 7 revision studies on lichens in Turkey. In one of these studies, 6 species of the genus *Hypogymnia* distributed in Turkey were examined in terms of taxonomic and lichen compounds [46]. In another study, the distribution of 23 species belonging to the genus *Peltigera*, their habitats and the lichenicol fungi living on them were studied [47]. In another study, morphological, anatomical, ecological and molecular analyzes of approximately 150 species belonging to the genus *Caloplaca* distributed in Turkey were carried out [39]. In another study, a modern revision of the species belonging to the genus *Usnea* was carried out [48]. In another study, ITS gene region analyzes of some species belonging to the genus *Lecidea*, which also spreads in Turkey, were performed and their phylogenetic relationships were revealed [49]. They carried out a modern revision study of *Cladonia* species distributed in Turkey with their morpho-anatomical characters, multilocus molecular sequence analyzes and secondary compounds [50]. Finally, it is a study on the determination of the morpho-anatomical

characters and multilocus molecular sequence analyzes of *Acarospora* species distributed in Turkey [51].



## CHAPTER 2

### DESCRIPTION OF RESEARCH AREA

#### 2.1. Location

Within the scope of the planned thesis study, Gökçeada a district of Çanakkale province, which is the largest island of Turkey, was chosen as the study area. In Gökçeada, which was chosen as the study area, it was planned to conduct field studies in 5 different localities representing different habitats within the scope of the thesis and the planned localities were marked on the Google Earth program (Figure 2.1).

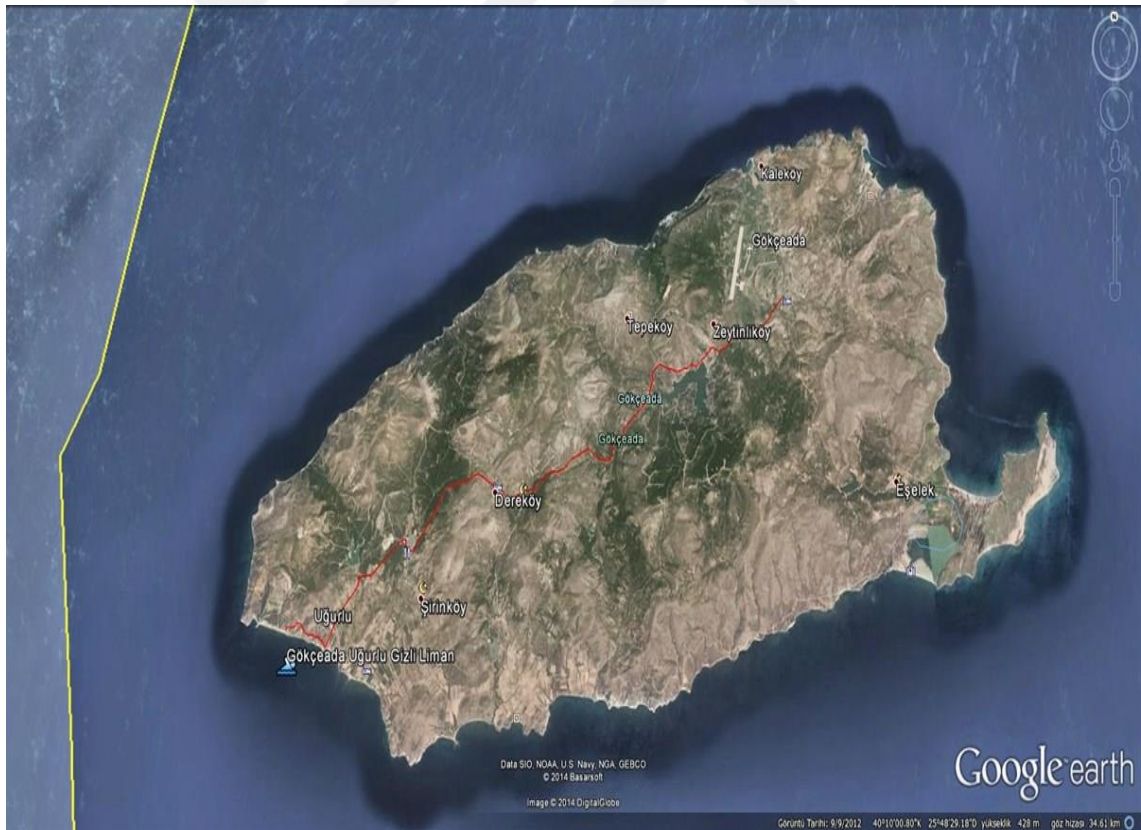


**Figure 2.1.** Gökçeada map

Gökçeada is Turkey's largest island with a surface area of 289.5 square kilometers and a coastline of 95 kilometers. The island has a length of 29.5 kilometers from east to west and 13 kilometers in the north-south direction [52].

Located in the west of the Çanakkale Bosphorus, Gökçeada is one of the two islands in the Aegean Sea, along with its younger brother Bozcaada. Gökçeada, which is in a very important strategic position for the security of the Bosphorus, has a volcanic ground like all the islands in the Aegean Sea. There is Lemnos in the east and Samotraki Island in the north.

Gökçeada, which has a very rugged landform due to its sitting on a volcanic ground, is rich in arable land, but the small area of the plains affects agriculture. Doruk Hill, the highest point of Gökçeada, has a height of 673 meters.

## **2.2. Geological Features of the Island**

The island, like other Aegean islands, consists of rocks formed in the young geological period. Young geological rocks welcome you in almost every part of the island in unique ways with the effect of wind, rain and earthquakes.

Gökçeada is located in the subduction zone in the North Aegean. For this reason, it gets closer to the Edirne-Enez line every year and takes the Trakya zone under it as it rises. This is the reason why the landforms in the north of the island seem to rise towards the sea. The Cheese Cliffs in Kaleköy, Kaşkaval Cape and the rock formations in Yıldız Bay are also due to the activity in this subduction zone [53].



**Figure 2.2.** Gökçeada Yıldız Cove

There is a continuation of the North Anatolian Fault line between Gökçeada and its northern neighbor Samotraki Island. Although this fault is quite active and active, it produces earthquakes with a magnitude of 7.4. In addition, this section constitutes the deepest point of the Aegean Sea, and it is known that there are sections where the depth exceeds 1 kilometer.

There are granite, iron and especially slate used in architecture in Gökçeada, which hosts different types of rocks geologically [53].

### **2.3. Vegetation**

Although Gökçeada generally has barren lands, it could not be afforested due to factors such as insufficient afforestation due to fires that occurred over time, inadequate response to fires and free livestock breeding. However, all kinds of plants can be grown due to the fertile soil structure.

The general geographical feature of the island is forest, maquis and of course olive groves. It covers thorny vegetation, which is generally referred to as geven. There are widespread red pine forests in the northern parts of the island, which is closed to settlement, such as the Marmaros region [53].



**Figure 2.3.** General vegetation

## 2.4. Climate

In Gökçeada, different climate types can be experienced in every period, and very large temperature and wind changes can be experienced in the same day. In general, continental climate is observed in the northern part of the island and the Mediterranean climate is observed in the southern parts. It is necessary to pay attention to the north wind in the harsh winter months and the southwesterly in the summer months. In Gökçeada, where southeastern storms can be seen frequently, the wind that affects transportation the most is the southwestern wind. Although the southeastern storms bring the life on the island to a standstill, severe storms that can reach 110 kilometers per hour can be seen.

In Gökçeada, which spends almost 320 days of the year completely windy, the sector where the most important investment is expected is wind and water sports. Considered among the most important wind sports destinations of Türkiye, Gökçeada hosts thousands of foreigner sports tourists every year [52].

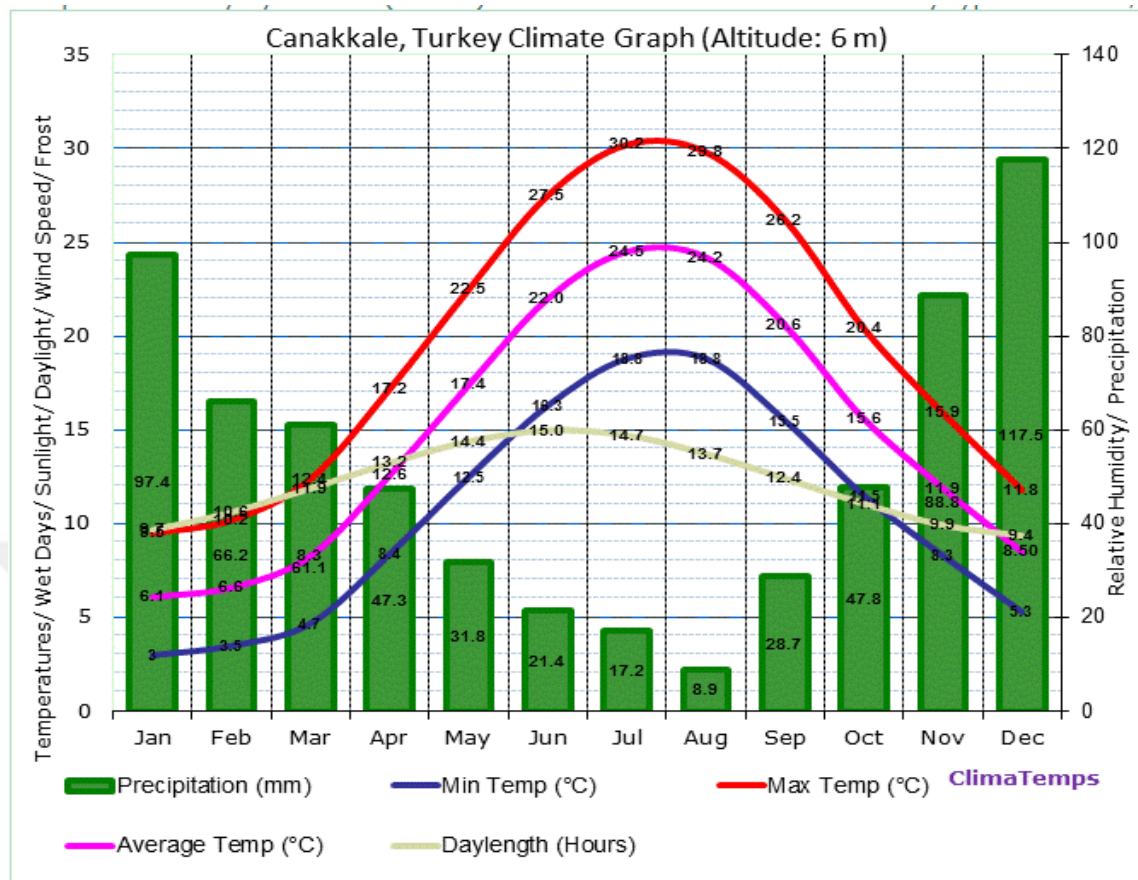


**Figure 2.4.** Average temperature and precipitation

The "mean daily maximum" (solid red line) shows the maximum temperature of an average day for every month for Gökçeada. Likewise, the "mean daily minimum" (dark blue line) indicates the average minimum temperature [52,53].

## CHAPTER 3

### MATERIAL AND METHOD

#### 3.1. MATERIAL

##### 3.1.1. Lichen Material

All lichen samples were collected from Çanakkale (Gökçeada) Province, Turkey. All the lichen specimens belonging to the study area preserved in the lichen herbarium of Erciyes University Faculty of Science (ERCH). Localities are provided in the table below (Table 3.1).

**Table 3.1.** Localities where lichen samples were collected

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**Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vejetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November. 2019. M. G. HALICI, MARWAN KHALAF.**

**Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, stepe vegetation, 40° 08' 49.79" N, 25° 56' 37.03" E, alt. 32 m, 28 November. 2019. M. G. HALICI, MARWAN KHALAF.**

**Turkey, Çanakkale, Gökçeada, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, alt. 200 m, 29 November 2019. M. G. HALICI, MARWAN KHALAF.**

**Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021. M. G. HALICI, MARWAN KHALAF.**

**Turkey, Çanakkale, Gökçeada, Dereköy, 40° 51' 44.15" N, 25° 32' 16.12" E, alt. 150 m, 28 October 2021 M. G. HALICI, MARWAN KHALAF.**

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Samples that were collected from the study area according to the properties of each lichen group were turned into herbarium material by drying. Materials that were turned into herbarium were taken out of bags and left to dry at room temperature for a while.

These dried samples were labelled by putting into special lichen envelopes. Various flora books, determination keys and molecular data that will be obtained through molecular studies are used in determining the lichen species (Kaynak). Ascospore morphologies of lichens and colour reactions they show with chemical reagents was used. The samples that were turned into herbarium material are now stored in the Lichen Herbarium of Faculty of Science of Erciyes University (ERCH).

So far, approximately 300 lichenized and lichenicolous fungi were reported from Turkey. A list of these species is given in (Table 3.2).

**Table 3.2.** List of species distributed in Çanakkale.

| Species                                              | Literature                                                                                                |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <i>Acarospora fuscata</i> (Ach.) Arnold              | Çobanoğlu & Sevgi (2006)                                                                                  |
| <i>Acarospora hilaris</i> (Dufour ex Nyl.) Arnold    | Huneck & John (1987); John (1992); John (1995); Egea & Alonso (1996); Nimis & John (1998)                 |
| <i>Acarospora impressula</i> Th. Fr.                 | Öztürk (1999)                                                                                             |
| <i>Alectoria sarmentosa</i> (Ach.) Ach.              | Çobanoğlu & Sevgi (2006)                                                                                  |
| <i>Amandinea punctata</i> (Hoffm.) Coppins & Scheid. | Özdemir Türk (1997); Özdemir Türk & Güner (1998); Karabulut et al. (2004); Oran & Öztürk (2012)           |
| <i>Anaptychia ciliaris</i> (L.) Körb. ex A. Massal.  | John (1992); Nimis & John (1998); Karabulut et al. (2004); Çobanoğlu & Sevgi (2006); Oran & Öztürk (2012) |
| <i>Anaptychia runcinata</i> (With.) J.R. Laundon     | John (1992); Nimis & John (1998)                                                                          |
| <i>Anaptychia setifera</i> Mereschk. ex Räsänen      | Karabulut et al. (2004)                                                                                   |

|                                                                                       |                                                                                                                          |
|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <i>Arthonia atra</i><br>(Pers.) A. Schneid.                                           | Öztürk, Ş. (1999)                                                                                                        |
| <i>Arthonia varians</i><br>(Davies) Nyl.                                              | Nimis & John (1998)                                                                                                      |
| <i>Aspicilia cinerea</i><br>(L.) Körb.                                                | Karabulut et al. (2004); Çobanoğlu & Sevgi (2006)                                                                        |
| <i>Aspicilia laevata</i><br>(Ach.) Arnold                                             | Karabulut et al. (2004)                                                                                                  |
| <i>Aspiciliella</i><br><i>cupreoglauca</i> (B.<br>de Lesd.) Zakeri,<br>Divakar & Otte | Nimis & John (1998); Karabulut et al. (2004)                                                                             |
| <i>Aspiciliella</i><br><i>intermutans</i> (Nyl.)<br>M. Choisy                         | Nimis & John (1998); Özdemir Türk & Güner (1998)                                                                         |
| <i>Athallia cerinella</i><br>(Nyl.) Arup, Frödén<br>& Söchting                        | Oran (2011)                                                                                                              |
| <i>Athallia holocarpa</i><br>(Hoffm.) Arup,<br>Frödén & Söchting                      | Özdemir Türk (1997); Özdemir Türk & Güner (1998);<br>Öztürk, Ş. (1999); Karabulut et al. (2004); Oran & Öztürk<br>(2012) |
| <i>Athallia inconnexa</i><br>(Nyl.) S.Y. Kondr.<br>& L. Lokos                         | Öztürk (1999)                                                                                                            |
| <i>Bacidia fraxinea</i><br>Lönnr.                                                     | Oran & Öztürk (2012)                                                                                                     |
| <i>Bacidia rosella</i><br>(Pers.) De Not.                                             | Oran & Öztürk (2012)                                                                                                     |
| <i>Bacidina phacodes</i><br>(Körb.) Vězda                                             | Öztürk (1999)                                                                                                            |
| <i>Blastenia</i><br><i>crenularia</i> (With.)<br>Arup, Söchting &<br>Frödén           | Özdemir Türk (1997); Nimis & John (1998)                                                                                 |

|                                                                |                                                                 |
|----------------------------------------------------------------|-----------------------------------------------------------------|
| <i>Blastenia ferruginea</i> (Huds.) A. Massal.                 | Oran & Öztürk (2012)                                            |
| <i>Bryoria fuscescens</i> (Gyeln.) Brodo & D. Hawksw.          | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004)               |
| <i>Buellia erubescens</i> Arnold                               | Oran & Öztürk (2012)                                            |
| <i>Buellia griseovirens</i> (Turner & Borrer ex Sm.) Almb.     | Çobanoğlu & Sevgi (2006); Oran (2011); Oran & Öztürk (2012)     |
| <i>Buellia spuria</i> (Schaer.) Anzi                           | Karabulut et al. (2004)                                         |
| <i>Buellia subdisciformis</i> (Leight.) Jatta                  | Karabulut et al. (2004); Scheidegger (1991); Scheidegger (1993) |
| <i>Calicium glaucellum</i> Ach.                                | Karabulut et al. (2004)                                         |
| <i>Calicium quercinum</i> Pers.                                | Karabulut et al. (2004)                                         |
| <i>Calicium salicinum</i> Pers.                                | Karabulut et al. (2004)                                         |
| <i>Calogaya biatorina</i> (A. Massal.) Arup, Frödén & Söchting | Nimis & John (1998)                                             |
| <i>Caloplaca adelphoparasitica</i> Nimis & Poelt               | Vondrák et al. (2012)                                           |
| <i>Caloplaca cerina</i> (Hedw.) Th. Fr.                        | Özdemir Türk & Güner (1998)                                     |
| <i>Caloplaca chlorina</i> (Flot.) Sandst.                      | Nimis & John (1998)                                             |
| <i>Caloplaca irrubescens</i>                                   | Nimis & John (1998)                                             |

|                                                |                                                                                                                                                  |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| (Arnold) Zahlbr.                               |                                                                                                                                                  |
| <i>Candelariella aurella</i> (Hoffm.) Zahlbr.  | Karabulut et al. (2004); Özdemir Türk (1997); Özdemir Türk & Güner (1998); Öztürk, Ş. (1999)                                                     |
| <i>Candelariella coralliza</i> (Nyl.) H. Magn. | Karabulut et al. (2004)                                                                                                                          |
| <i>Candelariella vitellina</i>                 | Çobanoğlu & Sevgi (2006) ; Karabulut et al. (2004); Özdemir Türk (1997a); Nimis & John (1998); Özdemir Türk & Güner (1998); Oran & Öztürk (2012) |
| <i>Candelariella xanthostigma</i>              | Özdemir Türk & Güner (1998); Oran (2011); Oran & Öztürk (2012)                                                                                   |
| <i>Catillaria lenticularis</i>                 | Özdemir Türk & Güner (1998)                                                                                                                      |
| <i>Catillaria nigroclavata</i>                 | Oran & Öztürk (2012)                                                                                                                             |
| <i>Cetraria aculeata</i>                       | Karabulut et al. (2004); Özdemir Türk (1997°)                                                                                                    |
| <i>Cetraria muricata</i>                       | Karabulut et al. (2004)                                                                                                                          |
| <i>Chaenotheca brunneola</i>                   | Karabulut et al. (2004)                                                                                                                          |
| <i>Chaenotheca phaeocephala</i>                | Karabulut et al. (2004)                                                                                                                          |
| <i>Chrysothrix candelaris</i>                  | Karabulut et al. (2004); Öztürk (1999)                                                                                                           |
| <i>Circinaria caesiocinerea</i>                | Özdemir Türk (1997); Çobanoğlu & Sevgi (2006)                                                                                                    |
| <i>Circinaria calcarea</i>                     | Öztürk (1999)                                                                                                                                    |
| <i>Circinaria contorta</i>                     | Özdemir Türk (1997); Özdemir Türk & Güner (1998)                                                                                                 |
| <i>Cladonia arbuscula</i>                      | Şenkardeşler (2009)                                                                                                                              |
| <i>Cladonia cervicornis</i>                    | Özdemir Türk (1997)                                                                                                                              |

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| <i>Cladonia chlorophaea</i>    | Çobanoğlu & Sevgi (2006); Oran (2011)                                                                                                 |
| <i>Cladonia coniocraea</i>     | Karabulut et al. (2004)                                                                                                               |
| <i>Cladonia convoluta</i>      | Güner & Özdemir (1986); Nimis & John (1998); Karabulut et al. (2004); Şenkardeşler (2009); Şen et al. (2014)                          |
| <i>Cladonia fimbriata</i>      | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran & Öztürk (2012)                                                               |
| <i>Cladonia firma</i>          | Karabulut et al. (2004); Nimis & John (1998); Şenkardeşler (2009)                                                                     |
| <i>Cladonia foliacea</i>       | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Özdemir Türk (1997); Nimis & John (1998); Özdemir Türk & Güner (1998)              |
| <i>Cladonia furcata</i>        | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004)                                                                                     |
| <i>Cladonia pyxidata</i>       | Karabulut et al. (2004); Oran (2011)                                                                                                  |
| <i>Cladonia ramulosa</i>       | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004)                                                                                     |
| <i>Cladonia rangiformis</i>    | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Nimis & John (1998); Özdemir Türk & Güner (1998); Şenkardeşler (2009); Oran (2011) |
| <i>Cladonia squamosa</i>       | Karabulut et al. (2004)                                                                                                               |
| <i>Cladonia verticillata</i>   | Karabulut et al. (2004)                                                                                                               |
| <i>Collema furfuraceum</i>     | Oran & Öztürk (2012)                                                                                                                  |
| <i>Collema rysssoleum</i>      | Oran & Öztürk (2012)                                                                                                                  |
| <i>Collema subflaccidum</i>    | Oran & Öztürk (2012)                                                                                                                  |
| <i>Dactylospora parasitica</i> | Oran & Öztürk (2012)                                                                                                                  |
| <i>Diploicia canescens</i>     | Özdemir Türk (1997); Nimis & John (1998)                                                                                              |

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| <i>Diploschistes actinostomus</i>   | Nimis & John (1998)                                                                                                                                                                                      |
| <i>Diploschistes caesioplumbeus</i> | Özdemir Türk (1997)                                                                                                                                                                                      |
| <i>Diploschistes muscorum</i>       | Nimis & John (1998)                                                                                                                                                                                      |
| <i>Diploschistes scruposus</i>      | Karabulut et al. (2004); Nimis & John (1998)                                                                                                                                                             |
| <i>Diplozomma alboatrum</i>         | Özdemir Türk (1997); Özdemir Türk & Güner (1998); Öztürk, Ş. (1999)                                                                                                                                      |
| <i>Diplozomma chlorophaeum</i>      | Özdemir Türk (1997)                                                                                                                                                                                      |
| <i>Diplozomma epipolium</i>         | Özdemir Türk (1997); Özdemir Türk & Güner (1998); Öztürk, Ş. (1999)                                                                                                                                      |
| <i>Enchylium polycarpon</i>         | Nimis & John (1998)                                                                                                                                                                                      |
| <i>Evernia divaricata</i>           | Çobanoğlu & Sevgi (2006); Şenkardeşler (2009)                                                                                                                                                            |
| <i>Evernia prunastri</i>            | Çobanoğlu & Sevgi (2006); Güner & Özdemir (1986); Karabulut et al. (2004); Özdemir Türk (1997); Nimis & John (1998); Özdemir Türk & Güner (1998); Şenkardeşler (2009); Oran (2011); Oran & Öztürk (2012) |
| <i>Flavoplaca calcitrata</i>        | Vondrák (2008); Vondrak et al. (2009)                                                                                                                                                                    |
| <i>Flavoplaca citrina</i>           | Özdemir Türk (1997); Karabulut et al. (2004)                                                                                                                                                             |
| <i>Flavoplaca havaasii</i>          | Vondrák (2008); Vondrak et al. (2009)                                                                                                                                                                    |
| <i>Flavoplaca limonia</i>           | Vondrák (2008); Vondrak et al. (2009)                                                                                                                                                                    |
| <i>Flavoplaca nigromarina</i>       | Vondrák (2008); Vondrak et al. (2009)                                                                                                                                                                    |
| <i>Fuscidea cyathoides</i>          | Karabulut et al. (2004)                                                                                                                                                                                  |

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| <i>Fuscidea praeruptorum</i>                                              | Karabulut et al. (2004)                                                                                           |
| <i>Fuscidea stiriaca</i>                                                  | Oran (2011)                                                                                                       |
| <i>Graphis scripta</i>                                                    | Karabulut et al. (2004)                                                                                           |
| <i>Gyalecta ulmi</i>                                                      | Oran & Öztürk (2011)                                                                                              |
| <i>Gyalolechia flavorubescens</i>                                         | Özdemir Türk & Güner (1998)                                                                                       |
| <i>Gyalolechia flavovirescens</i>                                         | Özdemir Türk & Güner (1998); Öztürk (1999)                                                                        |
| <i>Haematomma nemetzi</i>                                                 | John (1995); Karabulut et al. (2004); Nimis & John (1998); Szatala (1943)                                         |
| <i>Haematomma ochroleucum</i>                                             | Karabulut et al. (2004)                                                                                           |
| <i>Hafellia disciformis</i>                                               | Karabulut et al. (2004); Oran & Öztürk (2012)                                                                     |
| <i>Hypocenomyce scalaris</i>                                              | Karabulut et al. (2004)                                                                                           |
| <i>Hypogymnia farinacea</i>                                               | Karabulut et al. (2004); Çobanoğlu & Sevgi (2006); Oran (2011)                                                    |
| <i>Hypogymnia physodes</i>                                                | Karabulut et al. (2004); Çobanoğlu & Sevgi (2006); Oran & Öztürk (2012)                                           |
| <i>Hypogymnia tubulosa</i>                                                | Özdemir Türk (1997); Nimis & John (1998); Karabulut et al. (2004); Çobanoğlu & Sevgi (2006); Oran & Öztürk (2012) |
| <i>Icmadophila ericetorum</i>                                             | Karabulut et al. (2004)                                                                                           |
| <i>Intralichen christiansenii</i>                                         | Halıcı & Candan (2007)                                                                                            |
| <i>Kuettlingeria atroflava</i> (Turner)<br>I.V. Frolov,<br>Vondrák & Arup | Karabulut et al. (2004); Özdemir Türk (1997)                                                                      |
| <i>Kuettlingeria teicholyta</i> (Ach.)                                    | Özdemir Türk & Güner (1998)                                                                                       |

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| Trevis.                      |                                                                                      |
| <i>Lambiella insularis</i>   | Karabulut et al. (2004)                                                              |
| <i>Lasallia pustulata</i>    | John (1995); Karabulut et al. (2004); Nimis & John (1998)                            |
| <i>Lathagrium cristatum</i>  | Özdemir Türk (1997); Nimis & John (1998)                                             |
| <i>Lathagrium undulatum</i>  | Nimis & John (1998)                                                                  |
| <i>Lecania atrynoides</i>    | Öztürk, Ş. (1999)                                                                    |
| <i>Lecania cyrtella</i>      | Oran & Öztürk (2012)                                                                 |
| <i>Lecanora agardhiana</i>   | Öztürk, Ş. (1999)                                                                    |
| <i>Lecanora albella</i>      | Çobanoğlu & Sevgi (2006)                                                             |
| <i>Lecanora albescens</i>    | Özdemir Türk (1997)                                                                  |
| <i>Lecanora argentata</i>    | Oran (2011); Oran & Öztürk (2012)                                                    |
| <i>Lecanora carpinea</i>     | Karabulut et al. (2004); Çobanoğlu & Sevgi (2006); Oran (2011); Oran & Öztürk (2012) |
| <i>Lecanora chlarotera</i>   | Karabulut et al. (2004); Çobanoğlu & Sevgi (2006); Oran (2011); Oran & Öztürk (2012) |
| <i>Lecanora crenulata</i>    | Öztürk, Ş. (1999)                                                                    |
| <i>Lecanora dispersa</i>     | Özdemir Türk & Güner (1998)                                                          |
| <i>Lecanora expallens</i>    | Oran & Öztürk (2012)                                                                 |
| <i>Lecanora gangaleoides</i> | Çobanoğlu & Sevgi (2006)                                                             |
| <i>Lecanora glabrata</i>     | Oran (2011)                                                                          |
| <i>Lecanora hagenii</i>      | Oran & Öztürk (2012)                                                                 |
| <i>Lecanora intumescens</i>  | Oran (2011); Oran & Öztürk (2012)                                                    |
| <i>Lecanora jamesii</i>      | Arslan et al. (2011)                                                                 |

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| <i>Lecanora ochroidea</i>                | Nimis & John (1998)                                                                                                                    |
| <i>Lecanora polytropa</i>                | Çobanoğlu & Sevgi (2006); Özdemir Türk (1997)                                                                                          |
| <i>Lecanora pulicaris</i>                | Karabulut et al. (2004)                                                                                                                |
| <i>Lecanora rupicola</i>                 | Çobanoğlu & Sevgi (2006); Özdemir Türk (1997)                                                                                          |
| <i>Lecanora rupicola ssp. subplanata</i> | Karabulut et al. (2004)                                                                                                                |
| <i>Lecanora saligna</i>                  | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Özdemir Türk & Güner (1998)                                                         |
| <i>Lecanora subcarnea</i>                | Karabulut et al. (2004)                                                                                                                |
| <i>Lecanora sulphurata</i>               | Nimis & John (1998)                                                                                                                    |
| <i>Lecanora sulphurea</i>                | Karabulut et al. (2004); Özdemir Türk (1997)                                                                                           |
| <i>Lecanora symmicta</i>                 | Çobanoğlu & Sevgi (2006)                                                                                                               |
| <i>Lecanora varia</i>                    | Çobanoğlu & Sevgi (2006)                                                                                                               |
| <i>Lecidea atrobrunnea</i>               | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004)                                                                                      |
| <i>Lecidea fuscoatra</i>                 | Karabulut et al. (2004)                                                                                                                |
| <i>Lecidea plana</i>                     | Çobanoğlu & Sevgi (2006)                                                                                                               |
| <i>Lecidella asema</i>                   | Breuss & John (2004)                                                                                                                   |
| <i>Lecidella carpathica</i>              | Çobanoğlu & Sevgi (2006); Nimis & John (1998); Özdemir Türk & Güner (1998)                                                             |
| <i>Lecidella elaeochroma</i>             | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Özdemir Türk (1997); Özdemir Türk & Güner (1998); Oran (2011); Oran & Öztürk (2012) |
| <i>Lecidella stigmatea</i>               | Özdemir Türk (1997)                                                                                                                    |
| <i>Lepraria finkii</i>                   | Öztürk, Ş. (1999); Oran & Öztürk (2012)                                                                                                |
| <i>Lepraria incana</i>                   | Oran (2011); Oran & Öztürk (2012)                                                                                                      |

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| <i>Leprocaulon<br/>microscopicum</i>   | Nimis & John (1998)                                                                  |
| <i>Leproplaca<br/>cirrochroa</i>       | Özdemir Türk & Güner (1998)                                                          |
| <i>Leptochidium<br/>albociliatum</i>   | Nimis & John (1998)                                                                  |
| <i>Lethariella<br/>intricata</i>       | Karabulut et al. (2004)                                                              |
| <i>Lichenostigma<br/>maureri</i>       | Halıcı & Candan (2007)                                                               |
| <i>Lobaria<br/>pulmonaria</i>          | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran (2011); Oran & Öztürk (2012) |
| <i>Melanelixia glabra</i>              | Oran & Öztürk (2012)                                                                 |
| <i>Melanelixia<br/>glabratula</i>      | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran & Öztürk (2012)              |
| <i>Melanelixia<br/>subaurifera</i>     | Karabulut et al. (2004); Oran (2011); Oran & Öztürk (2012)                           |
| <i>Melanohalea<br/>elegantula</i>      | Karabulut et al. (2004); Özdemir Türk & Güner (1998)                                 |
| <i>Melanohalea<br/>exasperata</i>      | Oran & Öztürk (2012)                                                                 |
| <i>Melanohalea<br/>exasperatula</i>    | Oran (2011)                                                                          |
| <i>Melanohalea<br/>septentrionalis</i> | Karabulut et al. (2004)                                                              |
| <i>Micarea prasina</i>                 | Çobanoğlu & Sevgi (2006)                                                             |
| <i>Monerolechia<br/>badia</i>          | Nimis & John (1998)                                                                  |
| <i>Nephroma<br/>laevigatum</i>         | Karabulut et al. (2004)                                                              |
| <i>Nephroma</i>                        | Oran (2011)                                                                          |

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| <i>resupinatum</i>                                                                                  |                                                                                                              |
| <i>Ochrolechia arborea</i>                                                                          | Oran (2011); Oran & Öztürk (2012)                                                                            |
| <i>Ochrolechia balcanica</i>                                                                        | Karabulut et al. (2004)                                                                                      |
| <i>Ochrolechia crozalsiana</i>                                                                      | Nimis & John (1998)                                                                                          |
| <i>Ochrolechia pallescens</i>                                                                       | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran & Öztürk (2012)                                      |
| <i>Ochrolechia parella</i>                                                                          | Özdemir Türk (1997); Nimis & John (1998)                                                                     |
| <i>Ochrolechia subviridis</i>                                                                       | Oran & Öztürk (2011)                                                                                         |
| <i>Ochrolechia szatalaensis</i>                                                                     | Karabulut et al. (2004)                                                                                      |
| <i>Ochrolechia turneri</i>                                                                          | Oran & Öztürk (2012)                                                                                         |
| <i>Oleghlumia demissa</i> (Flot. ex Körb.) S.Y. Kondr., Lökös, Jung Kim, A.S. Kondr., S.O. Oh & Hur | Nimis & John (1998)                                                                                          |
| <i>Opegrapha hellespontica</i>                                                                      | Hafellner (2012); Vondrak & Kocourkova (2008)                                                                |
| <i>Parmelia saxatilis</i>                                                                           | Çobanoğlu & Sevgi (2006); Özdemir Türk (1997); Karabulut et al. (2004); Nimis & John (1998); Oran (2011)     |
| <i>Parmelia submontana</i>                                                                          | Oran (2011)                                                                                                  |
| <i>Parmelia sulcata</i>                                                                             | Çobanoğlu & Sevgi (2006); Güner & Özdemir (1986); Karabulut et al. (2004); Oran (2011); Oran & Öztürk (2012) |
| <i>Parmelina carporrhizans</i>                                                                      | Karabulut et al. (2004); Oran & Öztürk (2012)                                                                |

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| <i>Parmelina pastillifera</i> | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004)                                                         |
| <i>Parmelina quercina</i>     | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran & Öztürk (2012)                                   |
| <i>Parmelina tiliacea</i>     | Karabulut et al. (2004); Özdemir Türk (1997); Nimis & John (1998); Oran & Öztürk (2012)                   |
| <i>Parmeliopsis ambigua</i>   | Çobanoğlu & Sevgi (2006)                                                                                  |
| <i>Parmotrema perlatum</i>    | Oran & Öztürk (2012)                                                                                      |
| <i>Peltigera canina</i>       | Şenkardeşler (2009); Karabulut et al. (2004)                                                              |
| <i>Peltigera collina</i>      | Oran (2011)                                                                                               |
| <i>Peltigera didactyla</i>    | Çobanoğlu & Sevgi (2006)                                                                                  |
| <i>Peltigera neckeri</i>      | Karabulut et al. (2004)                                                                                   |
| <i>Peltigera praetextata</i>  | Karabulut et al. (2004); Oran (2011)                                                                      |
| <i>Peltigera rufescens</i>    | Nimis & John (1998)                                                                                       |
| <i>Peltula euploca</i>        | Nimis & John (1998)                                                                                       |
| <i>Pertusaria albescens</i>   | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran (2011); Şenkardeşler (2009); Oran & Öztürk (2012) |
| <i>Pertusaria amara</i>       | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran (2011)                                            |
| <i>Pertusaria flavicans</i>   | Nimis & John (1998)                                                                                       |
| <i>Pertusaria hymenea</i>     | Karabulut et al. (2004); Oran & Öztürk (2012)                                                             |
| <i>Pertusaria leioplaca</i>   | Oran & Öztürk (2012)                                                                                      |
| <i>Pertusaria leucosora</i>   | Karabulut et al. (2004)                                                                                   |

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| <i>Pertusaria pertusa</i>                               | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Özdemir Türk (1997); Oran (2011); Oran & Öztürk (2012)                                                                         |
| <i>Pertusaria pseudocorallina</i>                       | Nimis & John (1998)                                                                                                                                                               |
| <i>Pertusaria rupicola</i><br><i>subsp. coralloidea</i> | Nimis & John (1998)                                                                                                                                                               |
| <i>Phaeophyscia orbicularis</i>                         | Oran & Öztürk (2012)                                                                                                                                                              |
| <i>Phlyctis agelaea</i>                                 | Oran (2011)                                                                                                                                                                       |
| <i>Phlyctis argena</i>                                  | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran (2011); Oran & Öztürk (2012)                                                                                              |
| <i>Physcia adscendens</i>                               | Çobanoğlu & Sevgi (2006); Güner & Özdemir (1986); Karabulut et al. (2004); Özdemir Türk (1997); Özdemir Türk & Güner (1998); Öztürk, Ş. (1999); Oran (2011); Oran & Öztürk (2012) |
| <i>Physcia aipoila</i>                                  | Çobanoğlu & Sevgi (2006); Öztürk (1999); Şenkardeşler (2009); Oran & Öztürk (2012)                                                                                                |
| <i>Physcia dimidiata</i>                                | Oran & Öztürk (2012)                                                                                                                                                              |
| <i>Physcia leptalea</i>                                 | Özdemir Türk & Güner (1998)                                                                                                                                                       |
| <i>Physcia magnussonii</i>                              | Nimis & John (1998); Öztürk, Ş. (1999)                                                                                                                                            |
| <i>Physcia stellaris</i>                                | Karabulut et al. (2004); Özdemir Türk (1997); Oran & Öztürk (2012)                                                                                                                |
| <i>Physcia tenella</i>                                  | Oran & Öztürk (2012)                                                                                                                                                              |
| <i>Physcia tribacia</i>                                 | Nimis & John (1998)                                                                                                                                                               |
| <i>Physconia deterosa</i>                               | Oran & Öztürk (2012)                                                                                                                                                              |
| <i>Physconia distorta</i>                               | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran & Öztürk (2012)                                                                                                           |
| <i>Physconia enteroxantha</i>                           | Karabulut et al. (2004); Nimis & John (1998); Oran & Öztürk (2012)                                                                                                                |
| <i>Physconia grisea</i>                                 | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran &                                                                                                                         |

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|                                  | Öztürk (2012)                                                                                |
| <i>Physconia perisidiosa</i>     | Karabulut et al. (2004); Oran & Öztürk (2012)                                                |
| <i>Physconia servitii</i>        | Oran & Öztürk (2012)                                                                         |
| <i>Physconia subpulverulenta</i> | Oran & Öztürk (2012)                                                                         |
| <i>Placolecis opaca</i>          | Karabulut et al. (2004)                                                                      |
| <i>Placynthium nigrum</i>        | Özdemir Türk & Güner (1998)                                                                  |
| <i>Platismatia glauca</i>        | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Şenkardeşler (2009); Oran & Öztürk (2012) |
| <i>Pleurosticta acetabulum</i>   | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran & Öztürk (2012)                      |
| <i>Polychidium muscicola</i>     | Nimis & John (1998)                                                                          |
| <i>Porpidia albocaerulescens</i> | Çobanoğlu & Sevgi (2006)                                                                     |
| <i>Porpidia crustulata</i>       | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004)                                            |
| <i>Porpidia speirea</i>          | Karabulut et al. (2004)                                                                      |
| <i>Protoparmelia badia</i>       | Karabulut et al. (2004); Özdemir Türk (1997)                                                 |
| <i>Protoparmelia montagnei</i>   | Nimis & John (1998)                                                                          |
| <i>Protoparmelia memnonia</i>    | Karabulut et al. (2004)                                                                      |
| <i>Protoparmeliopsis muralis</i> | Nimis & John (1998)                                                                          |
| <i>Pseudevernia furfuracea</i>   | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Özdemir Türk (1997); Öztürk, Ş. (1999)    |
| <i>Psilolechia lucida</i>        | Karabulut et al. (2004)                                                                      |

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| <i>Pyrenodesmia aractina</i> (Fr.) S.Y. Kondr. | Nimis & John (1998)                                                                                       |
| <i>Ramalina calicaris</i>                      | Nimis & John (1998); Oran & Öztürk (2012)                                                                 |
| <i>Ramalina farinacea</i>                      | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Nimis & John (1998); Oran (2011); Oran & Öztürk (2012) |
| <i>Ramalina fastigiata</i>                     | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Oran (2011); Oran & Öztürk (2012)                      |
| <i>Ramalina fraxinea</i>                       | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Özdemir Türk (1997); Oran & Öztürk (2012)              |
| <i>Ramalina mediterranea</i>                   | Breuss & John (2004)                                                                                      |
| <i>Ramalina siliquosa</i>                      | Özdemir Türk (1997)                                                                                       |
| <i>Rhizocarpon badioatrum</i>                  | Karabulut et al. (2004)                                                                                   |
| <i>Rhizocarpon distinctum</i>                  | Çobanoğlu & Sevgi (2006)                                                                                  |
| <i>Rhizocarpon geographicum</i>                | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Nimis & John (1998)                                    |
| <i>Rhizocarpon lecanorinum</i>                 | Çobanoğlu & Sevgi (2006); Nimis & John (1998)                                                             |
| <i>Rhizocarpon polycarpum</i>                  | Karabulut et al. (2004)                                                                                   |
| <i>Rhizocarpon reductum</i>                    | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Nimis & John (1998)                                    |
| <i>Rhizocarpon subgeminatum</i>                | Karabulut et al. (2004)                                                                                   |
| <i>Rhizocarpon viridiatrum</i>                 | Karabulut et al. (2004); Nimis & John (1998)                                                              |
| <i>Rinodina beccariana</i>                     | Breuss & John (2004); Nimis & John (1998)                                                                 |

|                                     |                                                                                                                   |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <i>Rinodina calcarea</i>            | Özdemir Türk (1997)                                                                                               |
| <i>Rinodina confragosa</i>          | Nimis & John (1998)                                                                                               |
| <i>Rinodina exigua</i>              | Oran & Öztürk (2012)                                                                                              |
| <i>Rinodina milvina</i>             | Çobanoğlu & Sevgi (2006)                                                                                          |
| <i>Rinodina oleae</i>               | Öztürk, Ş. (1999)                                                                                                 |
| <i>Rinodina pyrina</i>              | Oran & Öztürk (2012)                                                                                              |
| <i>Rinodina sophodes</i>            | Oran & Öztürk (2012)                                                                                              |
| <i>Rinodina trachytica</i>          | Breuss & John (2004)                                                                                              |
| <i>Rufoplaca arenaria</i>           | Çobanoğlu & Sevgi (2006)                                                                                          |
| <i>Sagedia mastrucata</i>           | Karabulut et al. (2004)                                                                                           |
| <i>Schaereria fuscocinerea</i>      | Özdemir Türk (1997)                                                                                               |
| <i>Scoliciosporum umbrinum</i>      | Oran & Öztürk (2012)                                                                                              |
| <i>Scytinium gelatinosum</i>        | Çobanoğlu & Sevgi (2006)                                                                                          |
| <i>Scytinium palmatum</i>           | Nimis & John (1998)                                                                                               |
| <i>Squamarina cartilaginea</i>      | Nimis & John (1998)                                                                                               |
| <i>Strangospora moriformis</i>      | Oran & Öztürk (2012)                                                                                              |
| <i>Tephromela atra</i>              | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Özdemir Türk (1997); Nimis & John (1998); Oran & Öztürk (2012) |
| <i>Trapelia glebulosa</i>           | Karabulut et al. (2004)                                                                                           |
| <i>Trapelia obtegens</i>            | Karabulut et al. (2004)                                                                                           |
| <i>Tuckermannopsis chlorophylla</i> | Nimis & John (1998)                                                                                               |

|                                                                              |                                                                         |
|------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| <i>Umbilicaria crustulosa</i>                                                | Karabulut et al. (2004); Nimis & John (1998)                            |
| <i>Umbilicaria nylanderiana</i>                                              | Karabulut et al. (2004)                                                 |
| <i>Umbilicaria polyphylla</i>                                                | Karabulut et al. (2004)                                                 |
| <i>Usnea articulata</i>                                                      | Szatala (1943); Şenkardeşler (2009)                                     |
| <i>Usnea dasypoga</i>                                                        | Çobanoğlu & Sevgi (2006); Oran & Öztürk (2012)                          |
| <i>Usnea glabrescens</i>                                                     | Oran & Öztürk (2012)                                                    |
| <i>Usnea subfloridana</i>                                                    | Oran & Öztürk (2012)                                                    |
| <i>Vahliella leucophaea</i>                                                  | Nimis & John (1998)                                                     |
| <i>Varicellaria hemisphaerica</i>                                            | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004)                       |
| <i>Variospora aurantia</i>                                                   | Özdemir Türk (1997); Šoun & Vondrák (2008); Vondrak & Kocourkova (2008) |
| <i>Variospora dolomiticola</i>                                               | Öztürk, Ş. (1999)                                                       |
| <i>Variospora flavescens</i>                                                 | Öztürk, Ş. (1999)                                                       |
| <i>Variospora thallincola</i>                                                | Öztürk, Ş. (1999)                                                       |
| <i>Verrucaria muralis</i>                                                    | Karabulut et al. (2004)                                                 |
| <i>Verrucaria nigrescens</i>                                                 | Özdemir Türk (1997); Özdemir Türk & Güner (1998)                        |
| <i>Verrucaria subfuscilla</i>                                                | Nimis & John (1998)                                                     |
| <i>Xanthocarpia aquensis</i> (Houmeau & Cl. Roux)<br>Frödén, Arup & Söchting | Vondrák et al. (2011)                                                   |

|                                   |                                                                                                                                                               |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Xanthocarpia lactea</i>        | Özdemir Türk & Güner (1998)                                                                                                                                   |
| <i>Xanthocarpia marmorata</i>     | Vondrák et al. (2011)                                                                                                                                         |
| <i>Xanthoparmelia conspersa</i>   | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Nimis & John (1998)                                                                                        |
| <i>Xanthoparmelia pulla</i>       | Özdemir Türk (1997); Nimis & John (1998); Karabulut et al. (2004); Çobanoğlu & Sevgi (2006)                                                                   |
| <i>Xanthoparmelia stenophylla</i> | Karabulut et al. (2004); Çobanoğlu & Sevgi (2006)                                                                                                             |
| <i>Xanthoparmelia tinctina</i>    | Karabulut et al. (2004); Çobanoğlu & Sevgi (2006)                                                                                                             |
| <i>Xanthoria calcicola</i>        | Öztürk, Ş. 1999                                                                                                                                               |
| <i>Xanthoria parietina</i>        | Çobanoğlu & Sevgi (2006); Karabulut et al. (2004); Özdemir Türk (1997); Özdemir Türk & Güner (1998); Öztürk (1999) ; Şenkardeşler (2009);Oran & Öztürk (2012) |

## 3.2. METHOD

### 3.2.1. Preparation of lichen samples

Lichen species can develop along side other lichen species, mosses or plants. So it is exceptionally vital that the lichen sample is isolated from the diverse life forms. Lichen samples were isolated from diverse plant or lichen species beneath the microscope with the help of a pencil.

### 3.2.2. Identification method

The external morphology has invariably been studied under dissecting binocular microscope. The anatomy of the thallus and apothecia were studied under compound microscope. The anatomical structures were studied after cutting the sections of dry material with the help of safety razor blade. The colour of medulla, epithecium, hypothecium and ascus were recorded. The asci and ascospores were taken from the sections when sections were mounted in water and shapes, sizes were recorded. Secondary compounds of the specimens were

tested by spot tests.

### **3.2.3 Molecular determination method**

Molecular methods as well as morphologic data was used in the species identification of the lichens collected from the field.

#### **3.2.3.1. DNA isolation studies**

Qiagen Dneasy Plant Kit isolation method (modified) was used for DNA isolation. Qiagen Dneasy Plant Kit method yielded positive results in our studies. Stages of this method are as follows:

1. Pieces of apothecia and thalli are crushed by using mortar.
2. Samples are put into Eppendorf tubes by adding 400 µl AP1 Buffer.
3. 4 µl RNaz added on and it is mixed via Vortex.
4. Tubes are kept for 30 min by mixing at certain intervals at 65 °C water bath.
5. 130 µl P3 Buffer is added to the tubes after water bath and they are mixed. Then the samples are kept in ice for 5 min.
6. The samples taken from ice are centrifuged at 14000 rpm (20000 x g) for 5 min.
7. Supernatant on the top of the tubes are taken into blue led spin column (QIA shredder spin column) via pipette.
8. Liquid part at the bottom of the tubes is taken into a new 2 ml Eppendorf tube.
- 1.5 volume AWI Buffer is added on and it is well mixed via pipette.
9. This mixture is added to 650 µl white led spin column tubes (DNeast Mini spin column). Then it is centrifuged at 14000 rpm for 1 min. The liquid accumulated in the bottom 2 ml collection tubes is carefully removed after the centrifuge. This step is repeated for the mixture in the Eppendorf tube.
10. White part is put into a new 2 ml collection tube and 500 µl AW2 Buffer is added on. It is centrifuged at 14000 rpm for 1 min. The liquid part remaining in the bottom collection tubes is carefully removed by preventing

its contact with the white column.

11. Then 500 µl AW2 Buffer is added on again and it is centrifuged at 14000 rpm for 2 min.

12. White led spin column is carefully removed and put into 1,5 or 2 ml new micro centrifuge tube.

13. 50 µl AE Buffer is added on and it is kept at room temperature for 5 min. Then it is centrifuged at 14000 rpm for 1 min.

14. 25 µl AE Buffer is added on after the centrifuge and it is kept at room temperature for 5 min. It is centrifuged at 14000 rpm for 1 min.

15. Spin column is removed and DNA it is obtained in micro centrifuge tube as solved.

Obtained DNA amount determinations and degrees of purity are determined by spectrophotometric (Analytic Jena) measurements (260nm/280nm). Calculation is done by considering 1 OD has the absorbance value of the amount of 50µg/ml DNA at 260 nm wave number. The samples are loaded into 1% agarose-gel into which ethidium bromide dye as to be 5 mg/ml for electrophoresis analysis in the last volume. Existence of DNA bands are determined after moving at 100 watts for 30 min. under UV light.

### **3.2.3.2. Propagation of ITS Gen Zones**

Propagation of rDNA ITS zone in the isolated DNA was carried out by the primary covering the related area under proper PCR conditions. Studies done about related rDNA, ITS zones on different lichen species exist in the literature.

In 50 µ volume in the mixture of PCR reaction applied for ITS zones PCR reaction is executed by adding

- 200 ng DNA,
- 10X reaction buffer,
- 25mM MgCl<sub>2</sub>
- 25µ dNTP
- 10µM Primary
- 10µM Primary
- 0.5 U Tag DNA polymerase

– 21,5µl PCR water as to complete the total volume to 50µ.

#### **3.2.4 PCR cycle conditions:**

In this study ITS1F (CTTGGTCATTTAGAGAAGTAA) and ITS4 (TCCTCCGCTTATTGATATGC) was used as primary pair [54,55]. PCR programme was carried out as pre denaturation at 95 °C for 5 min., cycle amplification step at, 94 °C 30 sec., 55 °C 30 sec., 72 °C 1min 35, and the last extension step was carried out at 72 °C 8 min.

In this study, molecular studies on lichen samples collected from Gökçeada were carried out especially for the ITS gene region.

#### **3.2.5 Phylogenetic analysis**

Sequences obtained from collected the lichen samples were compared utilizing Blast program in NCBI website. “At that point, the results were edited in BioEdit program. Sequences were adjusted by utilizing Clustal w alternative within the BioEdit program. For phylogenetic tree, MEGA 7 (Molecular Evolutionary Genetics Analysis) program was utilized and genetic distances were decided by strategy Kimura-2-parameter. Phylogenetic trees of the lichen samples were performed by utilizing neighbor-joining method and Maksimum Likelihood method [56,57].

## CHAPTER 4

### RESULTS

#### 4.1. List of Identified Species, Locations, Distribution, Descriptions and Ecology

##### 4.1.1. *Acarospora fuscata* (Ach.) Arnold

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada- Eşelik highway, West of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.006].

**Description:** Thallus, areolate, 0.5-2(-3) mm in diameter, yellowish brown to deep reddish Brown. Apothecia, flat or convex, immersed, Brown. Asci, with more than 100 ascospores. Ascospores 4-6 x 1-1.5 µm. Chemistry, Cortex and sometimes medulla Pd-, K-, KC+ red, C+ pink.

**Substrate and ecology:** On granitic rocks in full or partial sun. The lichen sample (MAR 0.006) we collected is found on siliceous rocks.

**World distribution:** North America and Europe.

**Notes:** *Acarospora fuscata* (Ach.) Arnold is usually found in the interior, at medium elevations. Many C+ red species are mistakenly identified as *Acarospora fuscata*. *Acarospora fuscata* has an areolate thallus, while other species usually have a verrucous and scaly thallus. Specimens growing on rough surfaces are sometimes incorrectly identified as *Acarospora thamnina* (Tuck.) Herre. Like *Acarospora thamnina*, *Acarospora fuscata* gives a C+ red color, but the thallus *Acarospora thamnina* is also brighter [58].



**Figure 4.1.** *Acarospora fuscata* Thallus and apothecia.

#### **4.1.2. *Acarospora veronensis* A. Massal.**

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada- Eşelik highway, West of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.035].

**Description:** The thallus occurs in scattered or adjacent areoles. Areoles 1–2 mm wide, usually straight, rarely convex. Pruina rarely covers the entire surface of the thallus and is usually absent from all areoles. Pruinous areoles turn brown when wet (Fig. 3.58). Areoles rarely lobed and brown under surface. The upper cortex may be thin or absent. The algal layer is continuous, undivided by hyphae bands. Algal cells are about 15 μm in diameter. Apothecia embedded in the thallus, 0.1–0.5 mm wide, usually black, brown when wet and non-pruinous. The epihymenium is about 10 μm high and brown. The hymenium is usually more than 100 μm high, giving an I+ blue color. The hypothecium is narrow, usually 10 μm in length. Asci with more than 100 ascospores, 60–100 × 10–30 μm. Ascospores are simple, hyaline, measuring 3–5 × 2–2.5 μm.

**Substrate and ecology:** on acidic rocks and basalt, occasionally on wood. The lichen sample (MAR 0.035) we collected is found on siliceous rocks.

**World distribution:** Northern Hemisphere.

**Notes:** The most important feature of *Acarospora veronensis* A. Massal. is that the parathecia does not expand around the disc. Also, the hymenium is usually smaller than 100  $\mu\text{m}$ . In our example, the hymenium height has a measurement of 90  $\mu\text{m}$ . Another distinguishing feature is that when the Lugol test is applied to the hymenium, first a blue color is formed and then it turns red over time. Due to these features, it is easy to distinguish from other *Acarospora* species [58].

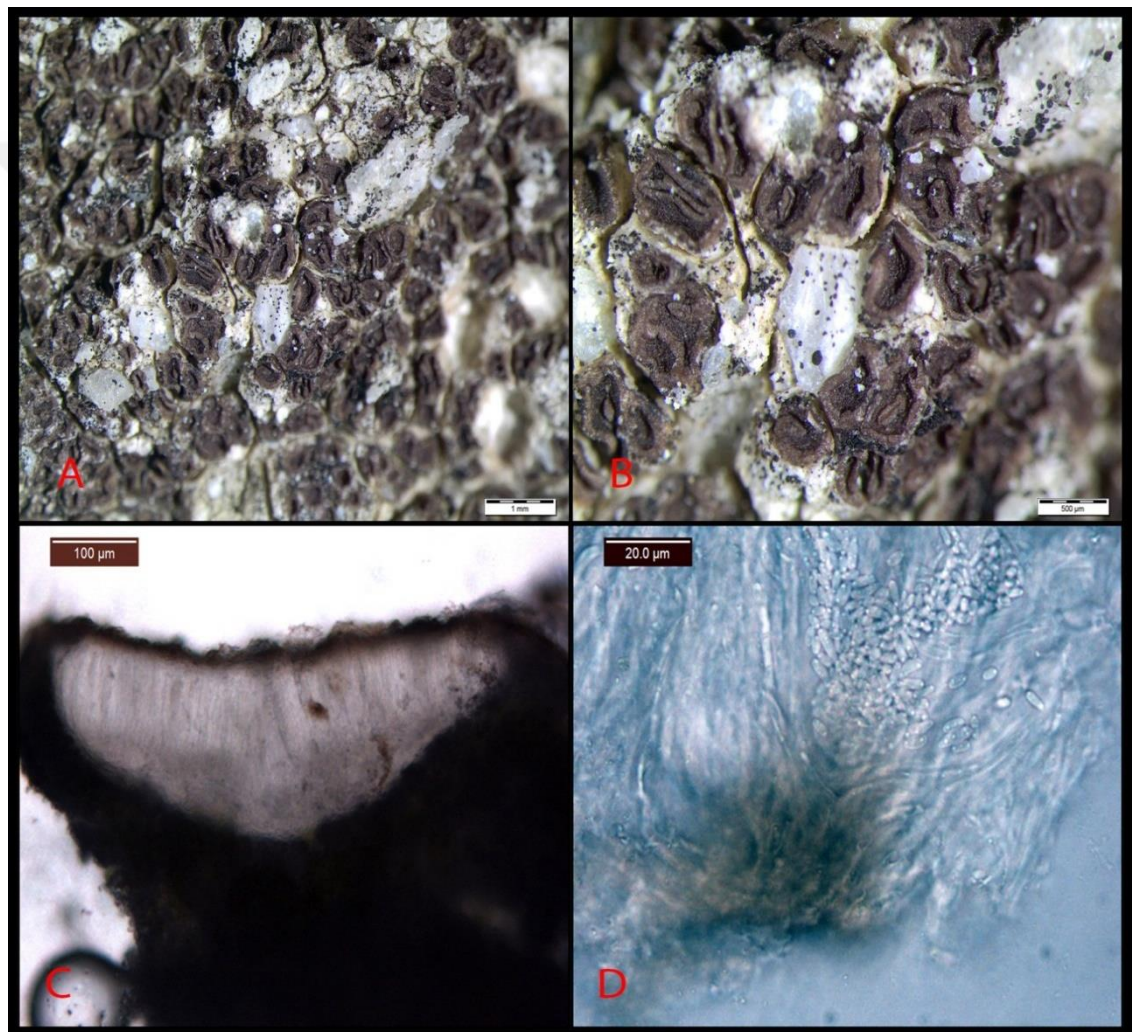


**Figure 4.2.** *Acarospora veronensis*. A and B. Thallus and apothecia. C. Apothetium cross section. D. Ascospores.

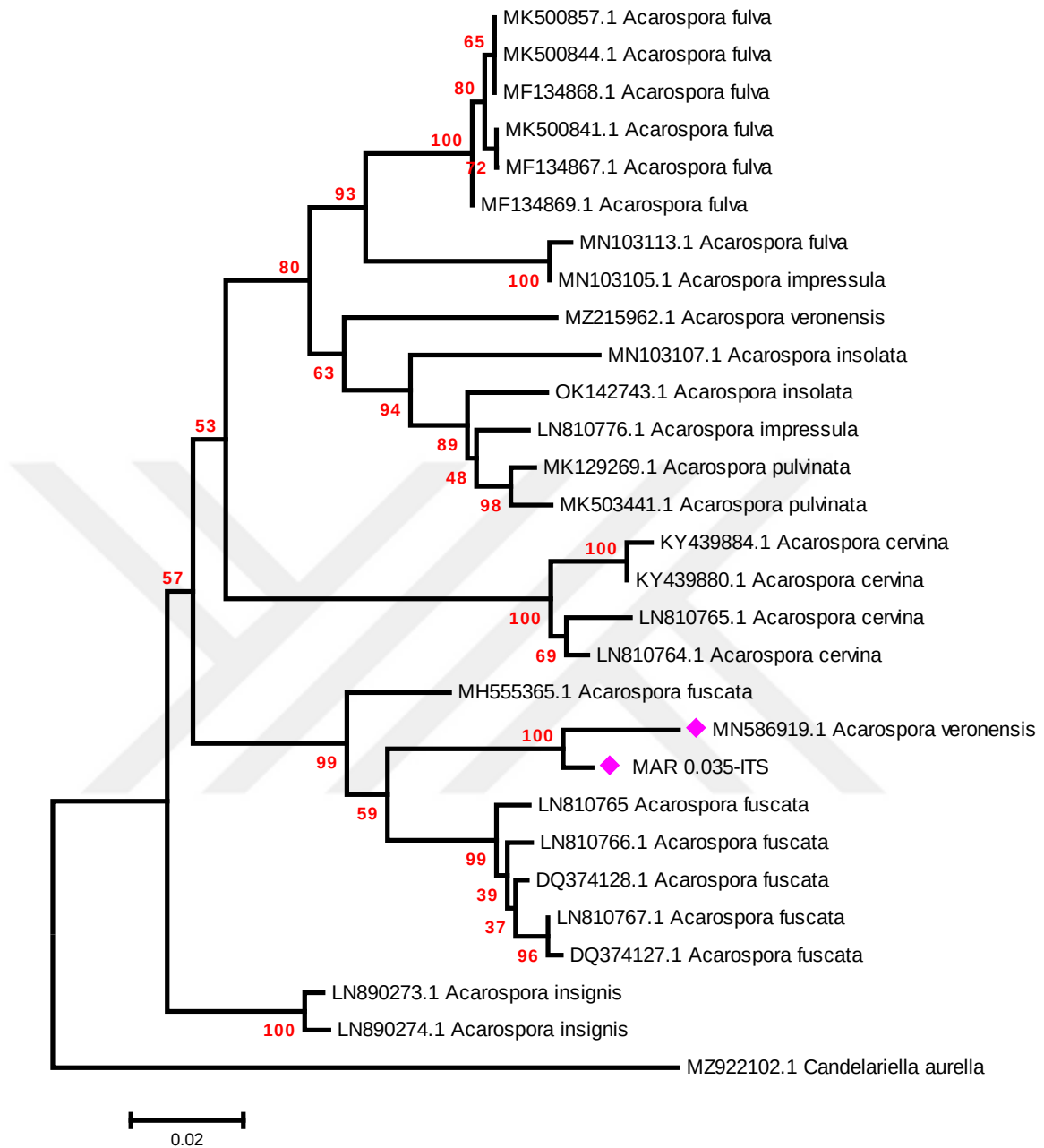


**Figure 4.3.** Neighbour-Joining dendrogram of *Acarospora veronensis* and related species (MAR 0.035).

#### 4.1.3. *Aspiciliella intermutans* (Nyl.) M. Choisy

**Specimens studied:** Turkey, Çanakkale, Gökçeada, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, alt. 200 m, 29 November 2019, [MAR 0.015]; . Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vejetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November. 2019, [MAR 0.019].

**Description:** Like *A.cinerea*, but ascospores (20-) 22-28 x (11-) 12-14  $\mu\text{m}$  and conidia 7-11  $\mu\text{m}$ ; apothecia 2-3 per areole; epithecium dark olive, N + green; paraphyses scarcely swollen to 2  $\mu\text{m}$  at tip; epithecium with an outer, clear, cellular cortical area. Thallus K + red, Pd + orange (norstictic acid).

**Substrate and ecology:** On low-lying rocks, slate roffs, etc., especially maritime. The lichen samples (MAR 0.015 and MAR 0.019) we collected is found on calcereous rocks.

**World distribution:** Europe, Asia, Africa.

**Notes:** *Aspiciliella* differs from *Aspicilia* in having small conidia, spores that are always ellipsoid and in producing norstictic acid.

The main distinguishing characteristics of the genera of Megarosporaceae are listed in Table 1. *Aspiciliella* is morphologically similar to *Aspicilia*, but differs in the size of its conidia and the shape of ascospores. In addition, norstictic acid was found in all species, which is also known in some species of *Aspicilia*. Therefore the chemical feature alone is not useful to distinguish both groups [58].

**Table 4.1.** The main distinguishing characteristics of the genera of Megasporaceae [58]:

| Character       | <i>Aspiciliella</i>         | <i>Aspicilia</i>                       | <i>Circinaria</i>                               | <i>Lobothallia</i>        | <i>Sagedia</i>             | <i>Megasporea</i>           |
|-----------------|-----------------------------|----------------------------------------|-------------------------------------------------|---------------------------|----------------------------|-----------------------------|
| Ascospores      | ellipsoid, 8 per ascus      | ellipsoid, rarely globose, 8 per ascus | broadly ellipsoid to globose, 2-6(-8) per ascus | ellipsoid, 8 per ascus    | ellipsoid, 8 per ascus     | ellipsoid, 4-8 per ascus    |
| Spore size      | 22-34 × 16-22 $\mu\text{m}$ | 10-27 × 8-19 $\mu\text{m}$             | 18-36 × 12-26 $\mu\text{m}$                     | 8-18 × 5-12 $\mu\text{m}$ | 14-25 × 7-14 $\mu\text{m}$ | 27-60 × 18-42 $\mu\text{m}$ |
| Conidia length  | 7-11 $\mu\text{m}$          | 11-40 $\mu\text{m}$                    | 6-12 $\mu\text{m}$                              | 3-8 $\mu\text{m}$         | 8-12 $\mu\text{m}$         | 8-12 $\mu\text{m}$          |
| Chemistry       |                             |                                        |                                                 |                           |                            |                             |
| Aspicilin       | –                           | –                                      | ±                                               | –                         | –                          | –                           |
| Substictic acid | –                           | ±                                      | –                                               | –                         | –                          | –                           |
| Norstictic acid | +                           | ±                                      | –                                               | ±                         | –                          | –                           |



**Figure 4.4.** *Aspiciliella intermutans* thallus and apothecia.

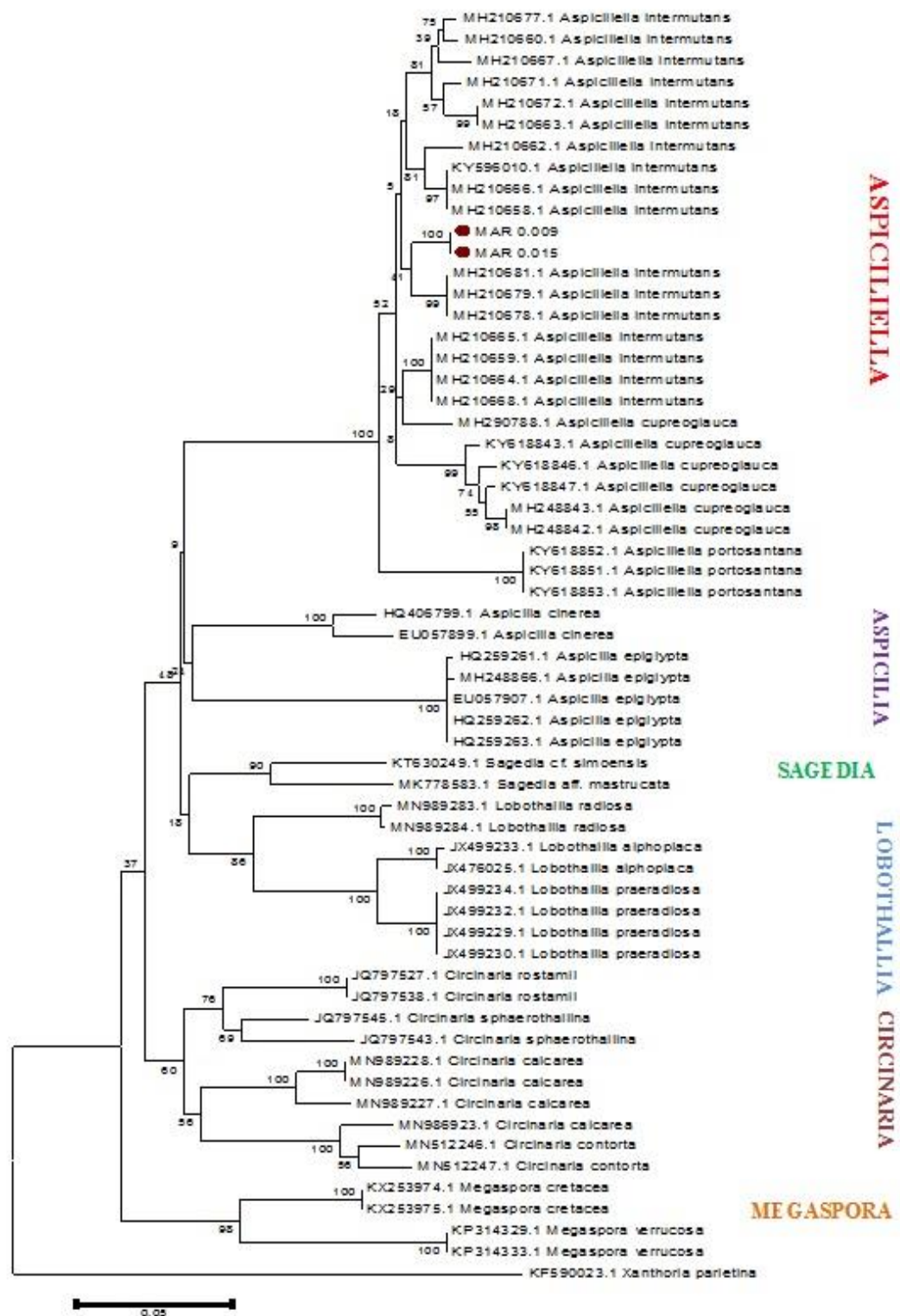


**Figure 4.5.** Neighbour-Joining dendrogram of *Aspiciliella intermutans* and related species (MAR 0.009 and 0.015).

#### 4.1.4. *Blastenia crenularia* (With.) Arup, Frödén & Söchting

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.037].

**Description:** Tallus light gray to dark gray, areolate, almost scaly in places and almost independent of substrate, but much thinner in some populations, white in places in the central parts. Apothecia present and numerous, adnate to sessile, dark orange to deep red, disc slightly concave, inner margin slightly higher than or at the same level as disc, outer margin mostly indistinct, (0.3–)0.47–0.65–0.83(–1) mm in diameter. Paraphyses simple, 3.5–6 µm in diameter at the tip. Ascospores (11.5–)13.5–14.8–16.1(–17.5) × (5.5–)7.3–8.35–9.4(–11) µm, septa (3.5–)4.85–5.85–6.85(–8) µm. Ascospore length/width ratio (1.3–)1.6–1.8–2(–2.6), septa/length ratio (0.2–)0.33–0.4–0.47(–0.55), Red-capped pycnidia common.

**Substrate and ecology:** On siliceous rocks. The lichen sample (MAR 0.037) we collected is found on siliceous rocks.

**World distribution:** Europe, North America.

**Notes:** Apothecia is almost blackish. Apothecial margins are matt, not lustrous, in *P. ceracea* [58]. The other related species *Caloplaca herbidella* (Hue) H. Magn. differs from this species by its epiphytic habit whereas *B. crenularia* (With.) Arup, Söchting & Frödén has a saxicolous habit.



**Figure 4.6.** *Blastenia crenularia*. Thallus and apothecia.

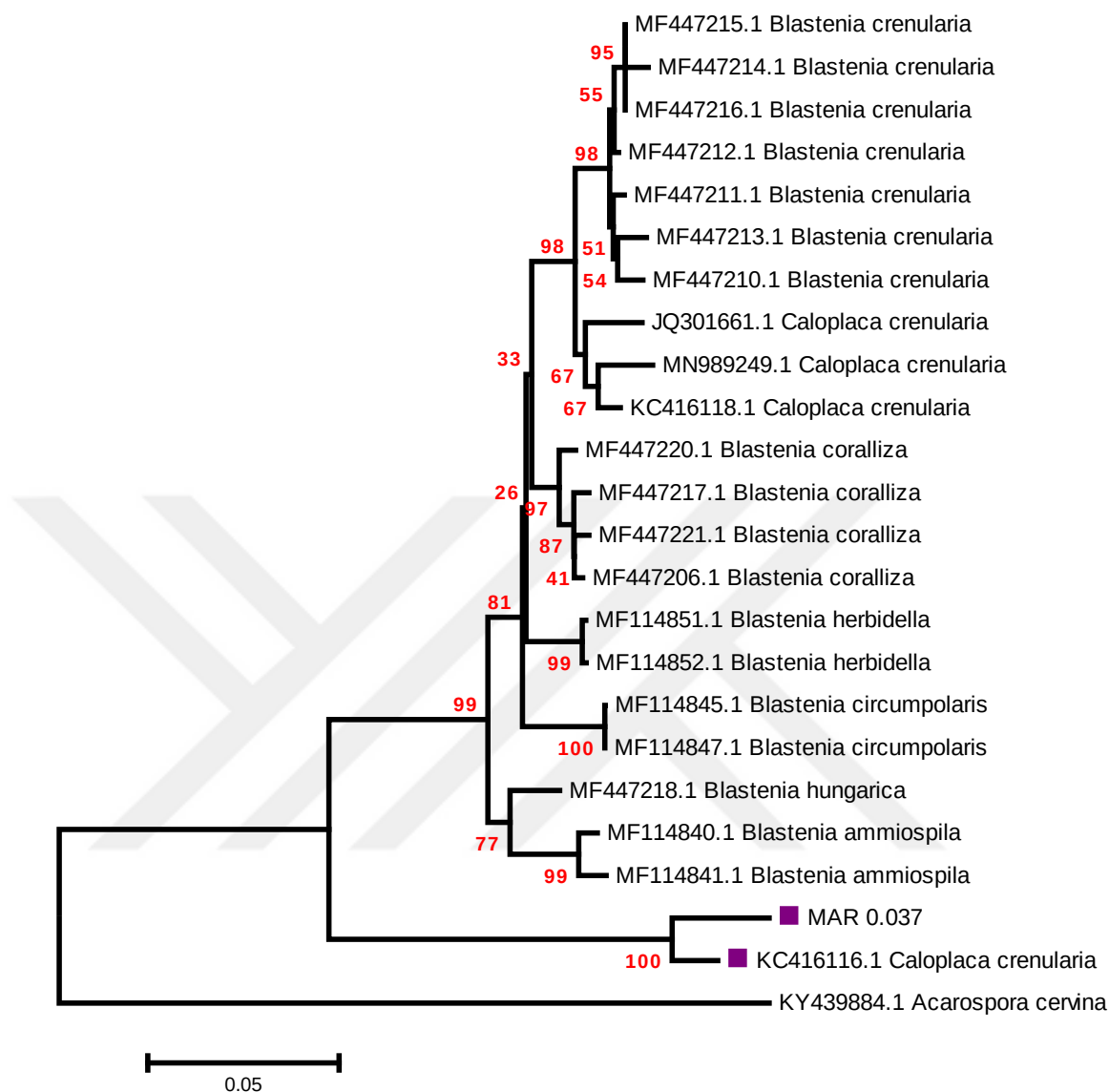


**Figure 4.7.** Neighbour-Joining dendrogram of *Blastenia crenularia* and related species (MAR 0.037).

#### 4.1.5. *Buellia subdisciformis* (Leight.) Jatta

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.041].

**Description:** Thallus, crustose, rimose to rimose-areolate, pale brown, rarely grayish brown, usually dull or ±rarely shiny, smooth, epruinose. Apothecia, lecideine; (0.2-)0.4-0.6(-0.8) mm, black. Hymenium, hyaline. Paraphyses, simple to moderately branched.

Asci, clavate, Bacidia-type, 8-spored. Ascospores, brown, 1-septate, oblong to ellipsoid, (9-)11.5-[13.8]-14.2(-16) x (5-)5.8[6.7]-7.6(-8)  $\mu\text{m}$  (n=60). Pycnidia, rare.

**Substrate and ecology:** epilithic, on siliceous rocks. The lichen sample (MAR 0.041) we collected is found on siliceous rocks.

**World distribution:** widespread in the Mediterranean region of Europe (Scheidegger 1993) and southwestern North America.

**Notes:** Scheidegger (1993) distinguishes the following morphologically, anatomically and ecologically. Based on the negative iodine" reaction of the medulla, the material is assigned here to *B. subdisciformis* [59].



**Figure 4.8.** *Buellia subdisciformis* thallus and apothecia.

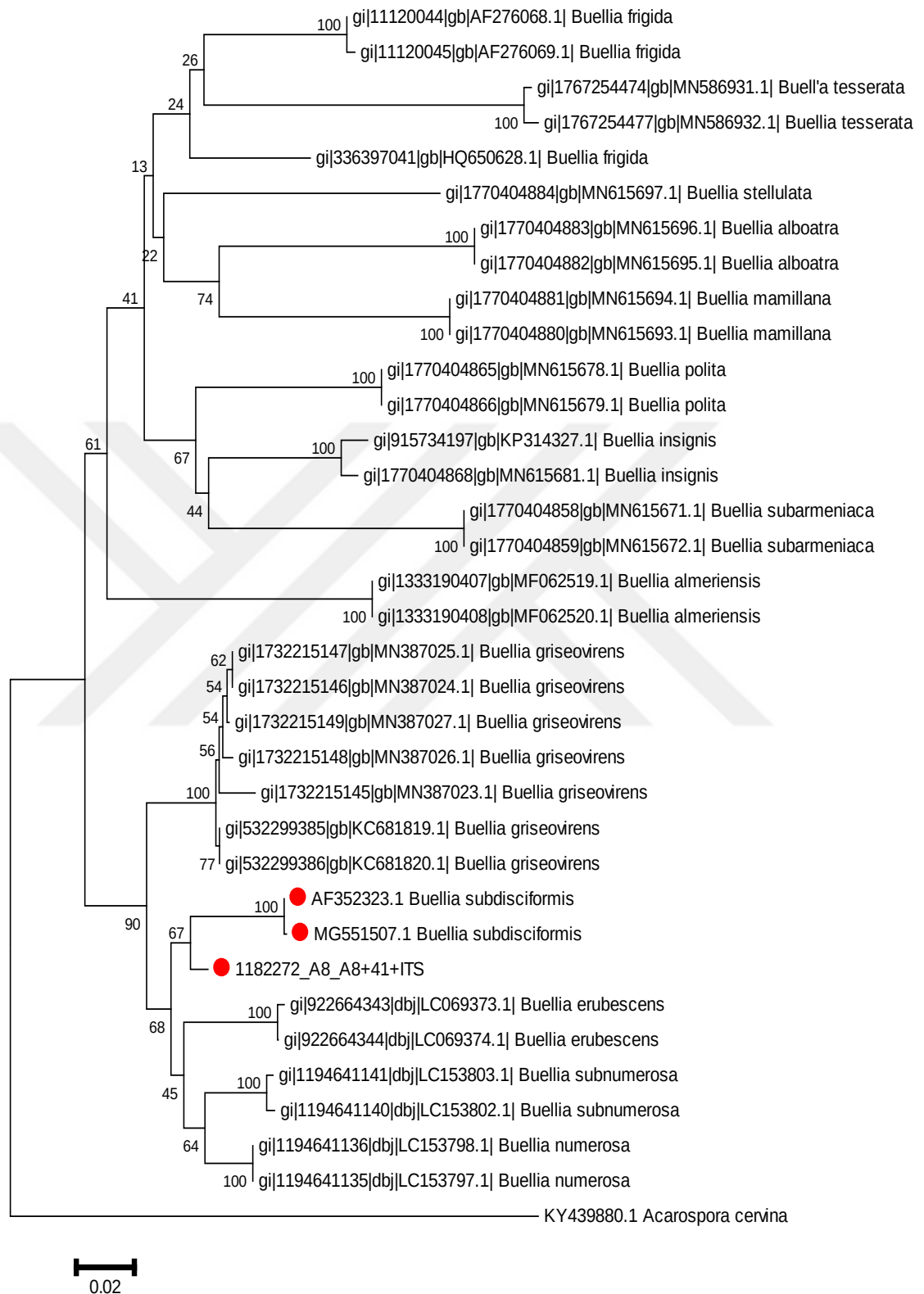


**Figure 4.9.** Neighbour-Joining dendrogram of *Buellia subdisciformis* and related species (MAR 0.041).

#### 4.1.6. *Candelariella aurella* (Hoffm.) Zahlbr

**Specimens studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vegetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November. 2019, [MAR 0.004]; Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.024].

**Description:** Thallus almost entirely within the substrate or consisting of scattered, dark yellow granules. Apothecia very abundant, 0.3-1.2 mm in a diameter; Asci, 8-spored, Ascospores 12-18 x 4.5-7.5 µm.

**Substrate and ecology:** On exposed calcareous rock or dust-impregnated wood or bark in areas with limerich soil. The lichen samples (MAR 0.004 and MAR 0.024) we collected is found on calcerous rocks.

**World distribution:** world-wide.

**Note:** Very few species of *Caloplaca* have the characteristic color of egg yolk seen in *Candelariella*. The spores and the chemical reactions are also entirely different. The southwestern desert genus *Candelina* has the same chemistry and spore type as *Candelariella*, differing in the radiating, convex, almost foliose lobes. Bright yellow species of *Acarospora* and *Pleopsidium* sometimes resemble *Candelariella*, but their apothecia are usually sunken into the thallus areoles and their asci generally contain hundreds of spores [58].



**Figure 4.10.** *Candelariella aurella*. Thallus.

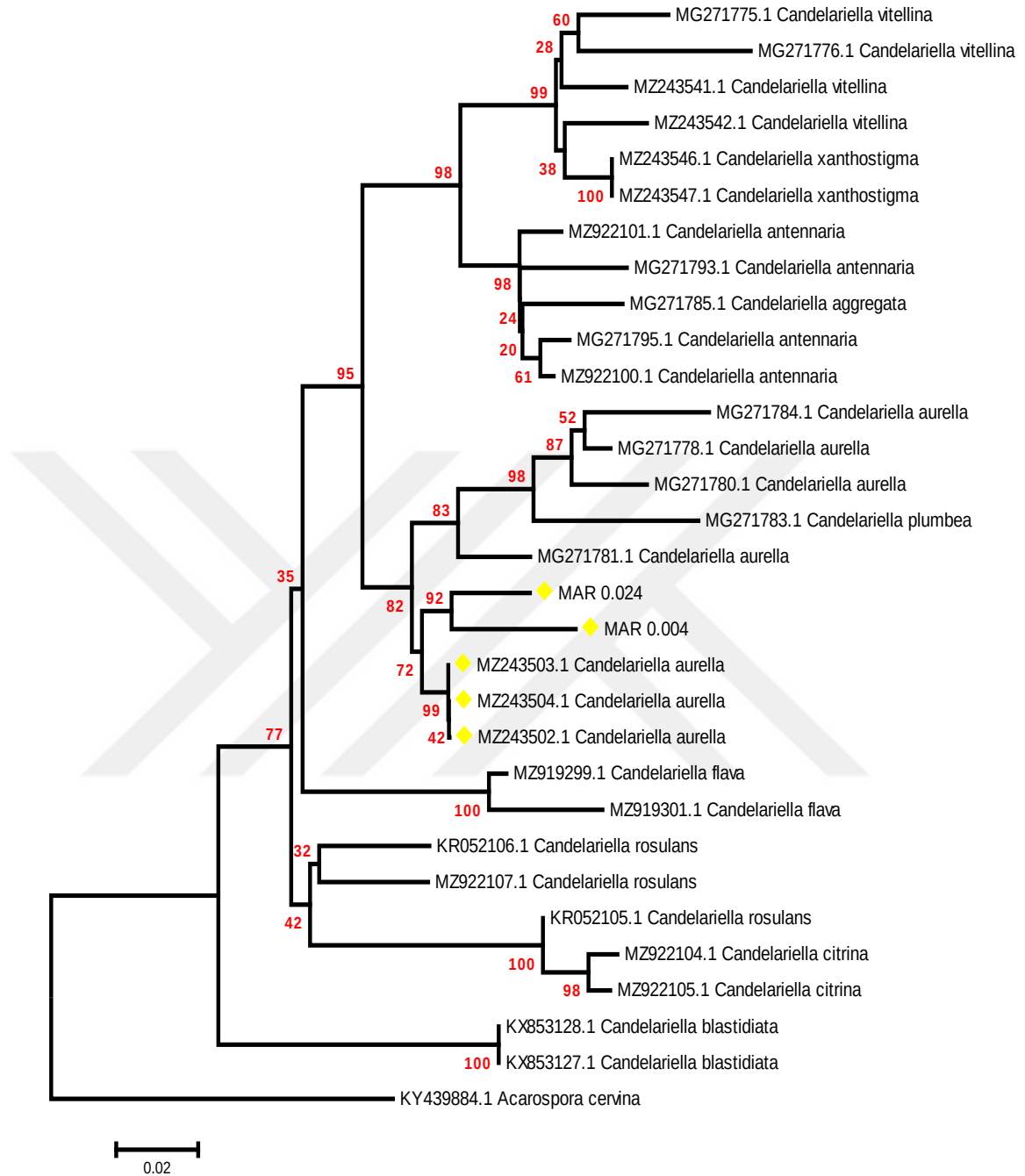


**Figure 4.11.** Neighbour-Joining dendrogram of *Candelariella aurella* and related species (MAR 0.004 and MAR 0.024).

#### 4.1.7. *Circinaria calcarea* (L.) A. Nordin, Savić & Tibell

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vegetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November. 2019, [MAR 0.043].

**Description:** Thallus, a chalky white (to pale blue-grey), smooth to cracked-areolate crust. Apothecia, black discs, or initially grey-pruinose, one or more per areole. Ascus, 4-8 spored, ascospores 18-30 x 14-27  $\mu\text{m}$ . Substrate and ecology, on hard limestone. It can be seen all year round.

**Substrate and ecology:** Common on calcereous rocks. Not on cement or mortar contorta common is more lichen on mortar and tombstones, often covering. Intolerant of nitrogen enrichment. The lichen sample (MAR 0.043) we collected is found on calcereous rocks.

**World distribution:** Europe and North America.

**Note:** Differs from *subsp. contorta* in its sometimes darker colour, more scurfy surface and areoles more distinctly angled when conjoined and more closely packed at the thallus margin [58].

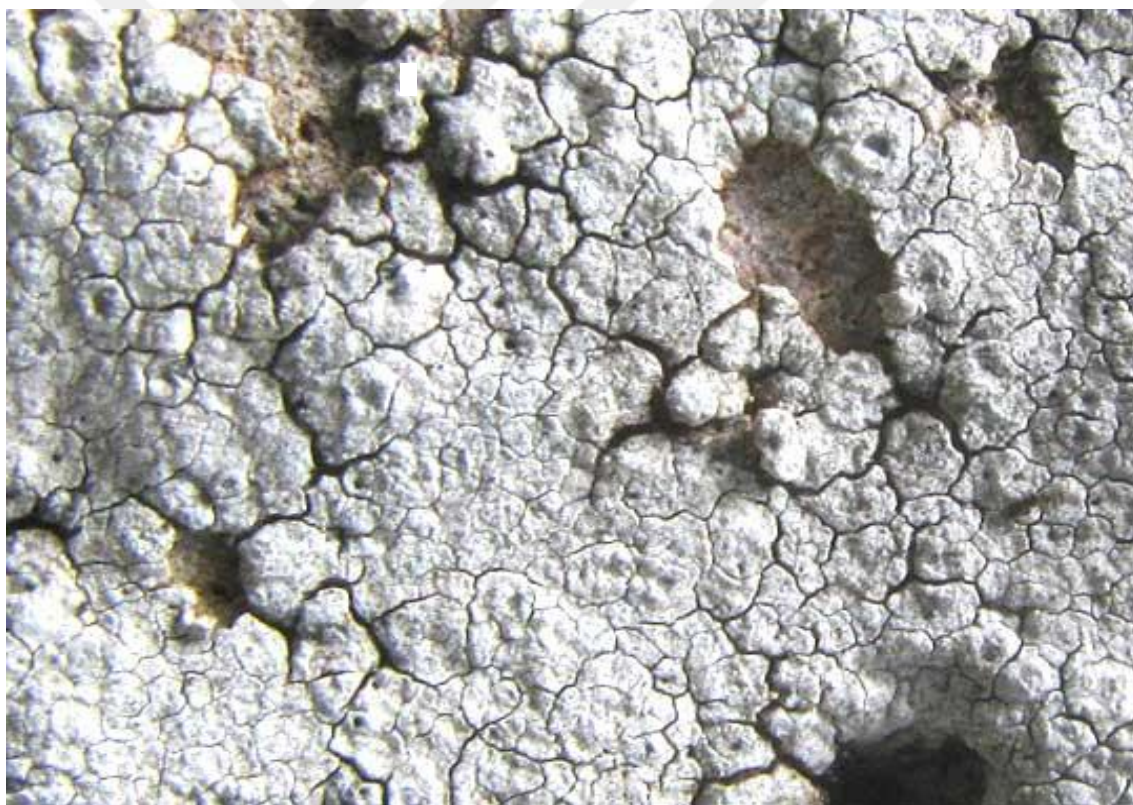


**Figure 4.12.** General view of *Circinaria calcarea*.

#### 4.1.8. *Circinaria mansourii* (Sohrabi) Sohrabi

**Specimen studied:** Çanakkale, Gökçeada, Dereköy, 40° 51' 44.15" N, 25° 32' 16.12" E, alt. 150 m, 28 October 2021, [MAR 0.032].

**Description:** Thallus terricolous, on soil or plant debris, lobes discrete, more or less stringy, 0.3–0.9(–1.3) mm in diameter. Surface with small cracks, white pruinose. Photobiont green, chlorococcoid. Medulla  $\pm$  loose to paraplectenchymatous. Lower surface white to pale yellow. Apothecia and pycnidia not known. Thallus (medulla) K–, C–, P–, KC–, CK–, I–.

**Substrate and ecology:** *Circinaria mansourii* (Sohrabi) Sohrabi has been found on soil and dead plant debris. It grows on calcareous soil in open situation. The lichen sample (MAR 0.032) we collected is found on soil.

**Word distribution:** Iran, Turkey.

**Notes:** Recently a new terricolous species, *Circinaria mansourii* (Sohrabi) Sohrabi, was described in Lumbsch et al. (2011) [60]. It contains aspicilin, and therefore its systematic position needs to be tested and compared with other species in *Circinaria*.



**Figure 4.13.** General view of *Circinaria mansourii*.

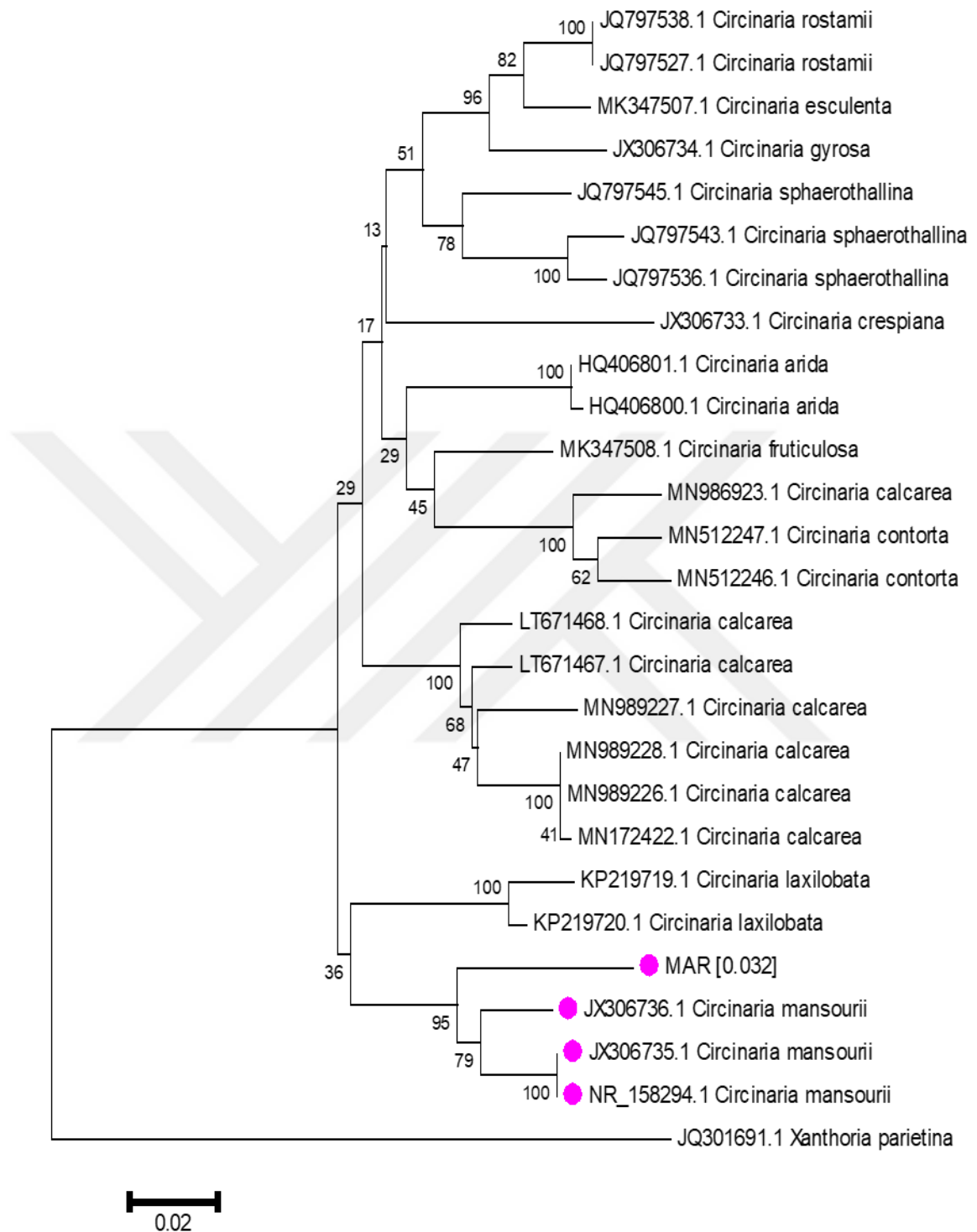


**Figure 4.14.** Neighbour-Joining dendrogram of *Circinaria mansourii* and related species (MAR 0.032).

#### 4.1.9. *Diplotomma alboatrum* (Hoffm.) Flot.

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.027].

**Description:** Thallus, thin to thick, often wide-spreading, white or pale (rarely dark) grey, smooth or rimose-cracked or granular,  $\pm$  determinate. Ascomata apothecia, 0.3-0.8(-1.5) mm diam., emergent; disc at first flat, later  $\pm$  convex, often strongly pruinose. Thalline exciple sometimes present but usually becoming excluded, white, sometimes  $\pm$  crenulate. True exciple inconspicuous, continuous with the hypothecium. Epithecium brown. Hymenium 45-75  $\mu$ m, tall, hyaline, I+ blue. Hypothecium brown, almost opaque. Interascal tissue of simple paraphyses with enlarged, pigmented apical cells. Asci (40-) 50-65 (-70)  $\times$  (10.5-)13-20 (-25)  $\mu$ m, clavate to clavate-ellipsoidal, Lecanora-type, 8-spored. Ascospores, arranged biseriately, (11-) 15-20 (-30)  $\times$  (5.5-) 8-10 (-17)  $\mu$ m, at first (1-)3-septate, mostly submuriform at maturity, dark greenish brown, smooth or faintly verrucose, without an epispore, gelatinous sheath or appendages.

**Substrate and ecology:** On bark or intermediate rocks. The lichen sample (MAR 0.027) we collected is found on calcereous rocks.

**World distribution:** Africa, Asia, Australia, Europe, North America, and South America.

**Notes:** *Diplotomma alboatrum* (Hoffm.) Flot. is distinguished from other *Diplotomma* species by having small brown submuriform ascospores and usually a small pruinose apothecia [61].



**Figure 4.15.** *Diplotomma alboatrum* thallus and apothecia.

#### **4.1.10. *Diplotomma venustum* (Körb.) Körb.**

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.029].

**Description:** Thallus, crustose, rimose, often subeffigurate, usually thick; chalky white to gray or ochraceous. Apothecia, lecideine, abundant 0.3-1.2 mm in diam., immersed or eventually raised above thallus surface disc: black, often pruinose. Epihymenium, brown. Hymenium, hyaline, 75-125 µm tall. Asci, Bacidia-type, 52-75 x 15-20 µm, 8-spored. Ascospores, brown, 3-septate, rarely with one or two longitudinal septa, ellipsoid, often curved, (14.5-)16 x (6.5-)10 µm. Pycnidia, rare, immersed. Thallus and medulla K-, P-, C-

**Substrate and ecology:** epilithic, on calciferous substrates, such as calcareous rocks, sandstone, schist, and anthropogenic substrates in open situations; at young stages sometimes parasitic on other lichens, such as *Lecanora spp.* The lichen sample (MAR 0.029) we collected is found on calcerous rocks.

**World distribution:** Europe, northern Africa, Asia, North America, and Greenland.

**Notes:** *Diplotomma venustum* (Körb.) Körb. is characterized by its thick, chalky, subeffigurate thallus, its apothecia that erupt from the thallus with a thalline collar and its 3-septate spores with a thick perispore. The species is similar to *D. alboatrum* (Hoffm.) Flot. and *D. subdispersum* (Mig.) Etayo & Breuss, and might also be mistaken for species with 1-septate spores, such as *B. Dispersa* A. Massal.. Only norstictic acid deficient specimens have been recorded in North America [58].



**Figure 4.16.** *Diplotomma venustum* thallus and apothecia.

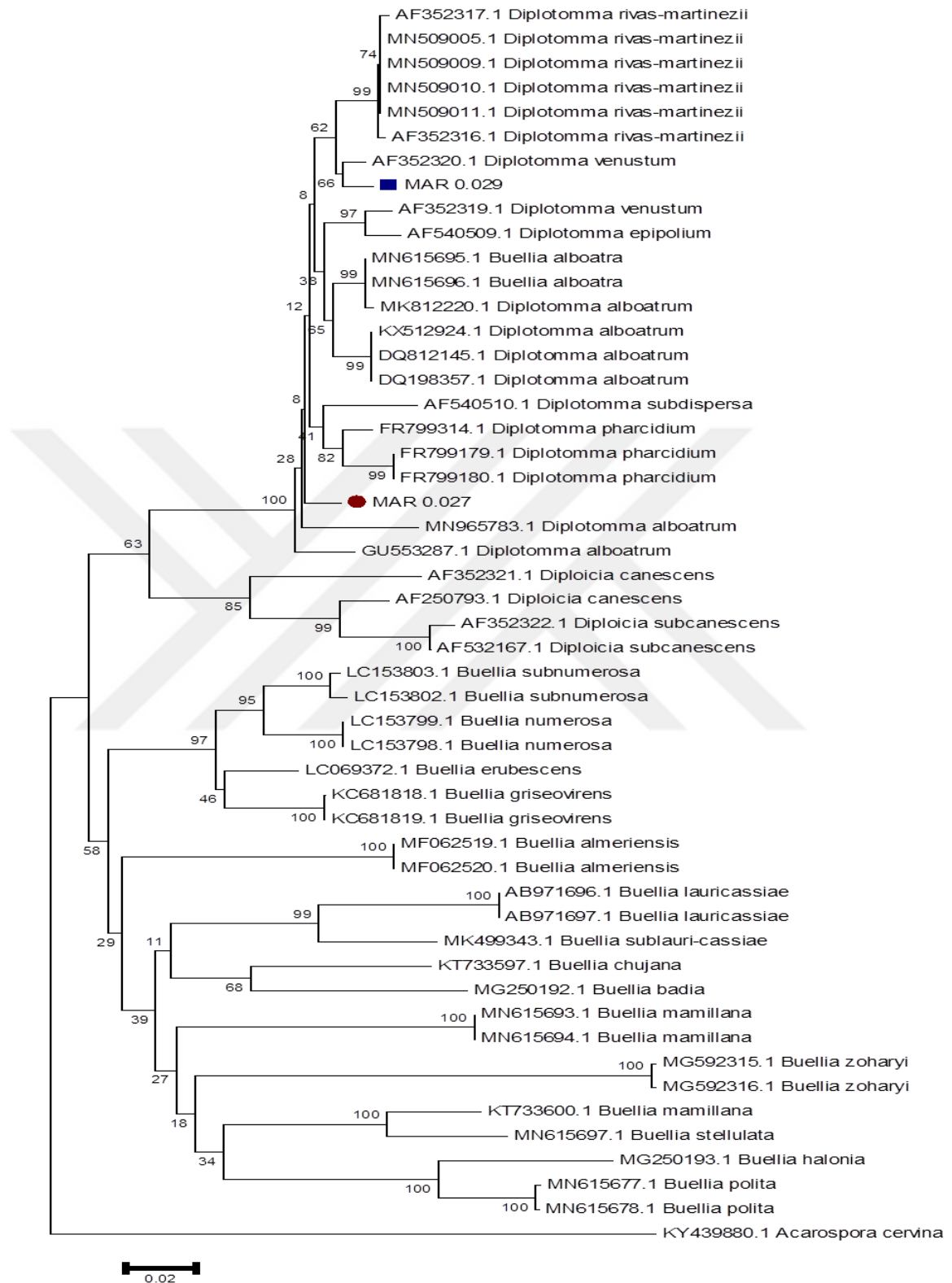


**Figure 4.17.** Neighbour-Joining dendrogram of *Diplotomma alboatrum*-*D. venustum* and related species (MAR 0.027 and MAR 0.029).

**4.1.11. *Glaucumaria sulphurea* (Hoffm.) S.Y. Kondr., L. Lőkös & Farkas, in Kondratyuk, Lőkös, Jang, Hur & Farkas**

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.040].

**Description:** Thallus a thick, cracked-areolate, greenish- or grey-yellow to yellow-grey crust. Apothecia initially immersed, yellowish to black, grey-pruinose. Thick warted and cracked, yellowish-grey to bright yellow-green thallus surrounded by greenish-black prothallus. The immersed pale, irregular apothecia become blackish with pale grey pruina. K- or K+ dirty-yellow, KC+ yellow.

**Substrate and ecology:** On Exposed nutrient-rich siliceous walls and rocks. Found on coast and inland. The lichen sample (MAR 0.040) we collected is found on siliceous rocks.

**World distribution:** Europe, North America, Arctic.

**Notes:** The thick, cracked, yellowish thallus lacking soralia helps to distinguish it from *Lecanora orosthea* (Ach.) Ach. which is a similar colour, but is always sorediate (dusty) [58].



**Figure 4.18.** *Glaucumaria sulphurea* thallus and apothecia.

#### 4.1.12. *Lecanora campestris* (Schaer.) Hue

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada- Eşelik highway, stepe vegetation, 40° 08' 21.00" N, 25° 56' 42.77" E, 29 m, 28 November 2019 [MAR 0.022].

**Description:** The thallus generally consists of round, swollen areoles. Light to dark gray, prothallus prominent and white in color. Apothecia 0.5-1.5(-2) mm in diameter, numerous, spread over the entire thallus surface and sessile. Disc red, brown, flat, sometimes convex. Epithecium pale orange to reddish brown in color. Hymenium 70-85 µm thick. Ascospores 10-14 x 6-9 µm, ellipsoid. Thallus P-, K + yellow, C-.

**Substrate and ecology:** On concrete and calcareous rocks. The lichen sample (MAR 0.022) we collected is found on calcerous rocks.

**World distribution:** Northern Africa, western Asia, western Europe, and southwestern North America [58].

**Notes:** *Lecanora campestris* (Schaer.) Hue is characterized by the presence of small crystals, light red-brown epihymenium and atronorine [58].



**Figure 4.19.** *Lecanora campestris*. Thallus and apothecia.

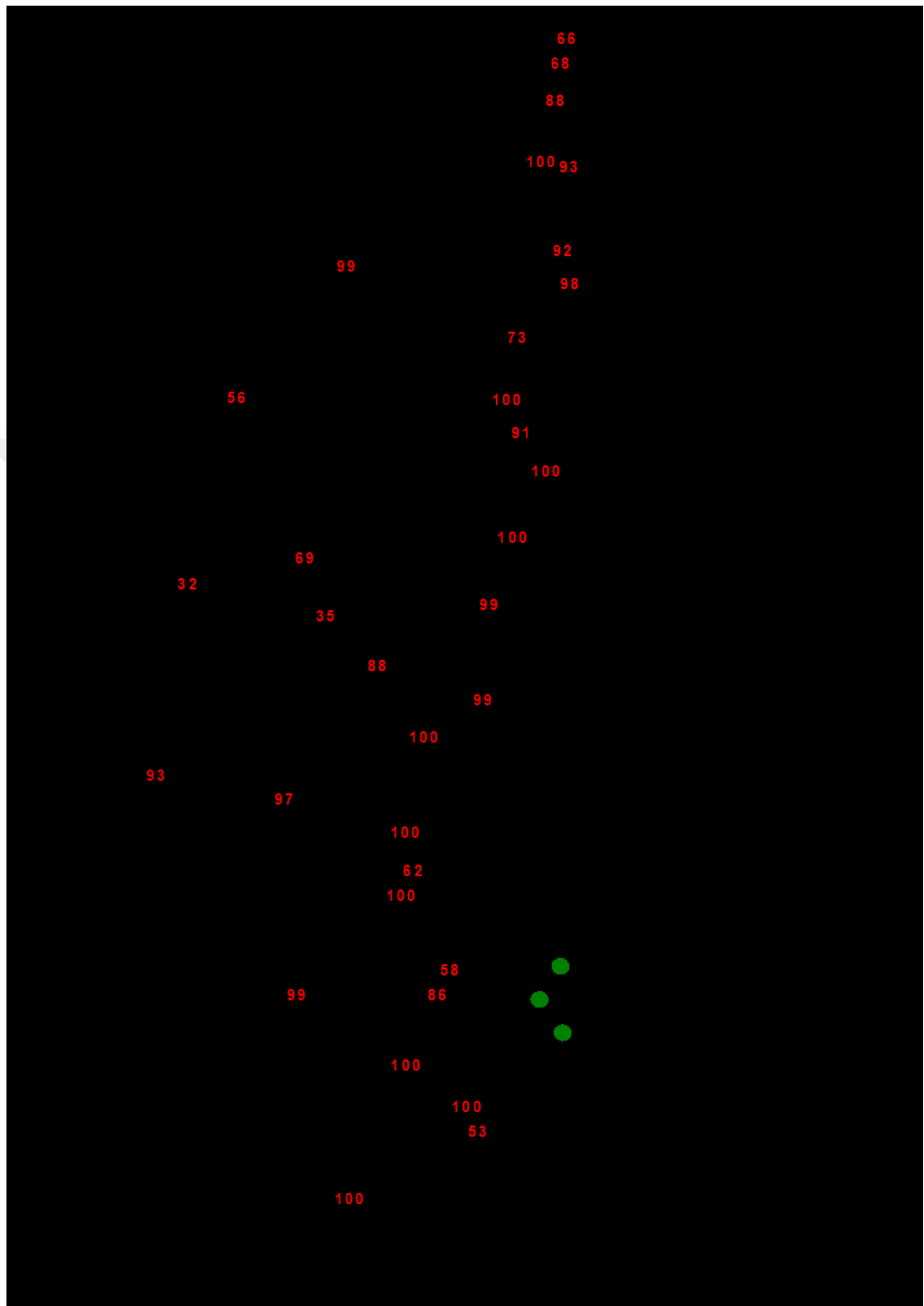


**Figure 4.20.** Neighbour-Joining dendrogram of *Lecanora campestris* and related species (MAR 0.022).

#### 4.1.13. *Lecanora chlarotera* Nyl.

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, steep vegetation, 40° 08' 49.79" N, 25° 56' 37.03" E, alt. 32 m, 28 November, 2019 [MAR 0.007].

**Description:** The thallus is smooth, rough or warty, light gray in color, forming continuous, regularly demarcated zones. Prothallus is absent. Apothecia 0.4-0.8(-1.5) mm in diameter; The thallin margin is well developed, complete or irregular crenulate or warty, coarse irregular crystals insoluble with K are found in the medulla. Disc flat, light brown, orange- or red-brown in color; The epithecium is colorless or grayish-brown, soluble in K, and has a granular structure. Ascospores are elliptical in size (9-)11-13(-15) x 6.5-7.5(-8.5) µm. Thallus Pd(-), K(+) yellow, C(-).

**Substrate and ecology:** It is a broad tolerant species that thrives on sparse trees up to the high parts of the mountains. It thrives on smooth bark, wood of broad-leaved trees and timber, in areas exposed to the sun and wind, and on roadside trees. The lichen sample (MAR 0.007) we collected is found on bark [62].

**World distribution:** Africa, Asia, Europe, and North and South America [62].

**Notes:** *Lecanora chlarotera* includes specimens with sessile apothecia with large amphithecial crystals, a granular epiphymenium, and the presence of the gangaleoidin chemosyndrome. *Lecanora chlarotera* is similar to *L. viruduloflava*, which differs in having heavily pruinose apothecial discs [62,63].



**Figure 4.21.** *Lecanora chlarotera*. Thallus and apothecia.

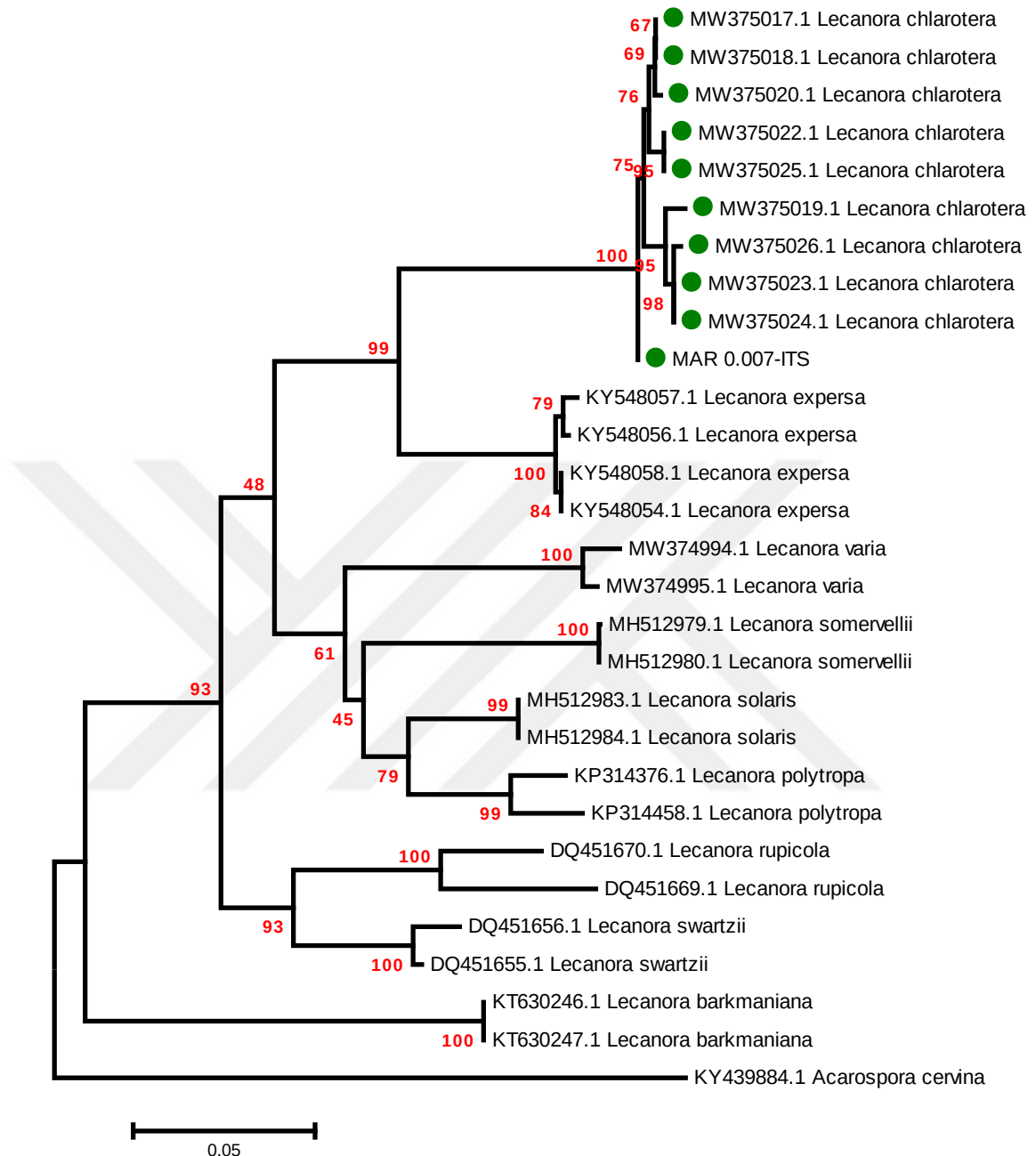


**Figure 4.22.** Neighbour-Joining dendrogram of *Lecanora chlarotera* and related species (MAR 0.007).

#### 4.1.14. *Lecanora rupicola* (L.) Zahlbr.

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, stepe vegetation, 40° 08' 49.79" N, 25° 56' 37.03" E, alt. 32 m, 28 November, 2019 [MAR 0.048].

**Description:** Thallus, crustose, whitish grey to ash-grey. Areoles flat, epruinose. Apothecia, lecanorine, (0.5-)1-2(-3) mm across, with a brown, grey-brown or black, but

heavily bluish-white-pruinose, usually flat disc, and a thin. Epithecium, almost colourless to yellowish or greenish brown. Hymenium, colourless, 75-95  $\mu\text{m}$  high. Paraphyses 2-3  $\mu\text{m}$  thick. Hypothecium, colourless. Asci, 8-spored, clavate, *Lecanora*-type. Ascospores, 1-celled, hyaline, ellipsoid, 9-15 x 5-8  $\mu\text{m}$ . Thallus K+ yellow, C-, KC-, P- or P+ pale yellow.

**Substrate and ecology:** Found on siliceous rocks and walls. . The lichen sample (MAR 0.048) we collected is found on siliceous rocks [58].

**World distribution:** Europe [58].

**Notes:** *Lecanora rupicola* (L.) Zahlbr. is characterized by the heavily pruinose apothecial disc lacking a parathecial ring and a whitish to yellowish gray thallus.



**Figure 4.23.** *Lecanora rupicola*. Thallus and apothecia.

#### 4.1.15. *Lecidella flavosorediata* (Vězda) Hertel & Leuckert

**Specimen studied:** Turkey, Çanakkale, Gökçeada, West of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.043].

**Description:** Thallus white to pale grey, very thin, filmy; weakly cracked with a

minutely bullate surface, usually mosaic-forming with other crustose lichens. Soredia arise from pustules, soon coalescing to form irregular, farinose areas and finally a continuous crust, c.20  $\mu\text{m}$  diam., pale green to brown-yellow, C + orange.

**Substrate and ecology:** On bark of *Populus tremula* and *Sorbus* in montane. Widespread in Europe. The lichen sample (MAR 0.048) we collected is found on siliceous rocks [58].

**World distribution:** Europe.

**Notes:** Distinguished *L. elaeochroma* f. *sorelifera* (Erichsen) D. Hawksw. which has UV + orange lichexanthone in discrete soralia, is always fertile and a cortex that usually persists, at least at the thallus edge [58].



**Figure 4.24.** *Lecidella flavosorediata* thallus and apothecia.

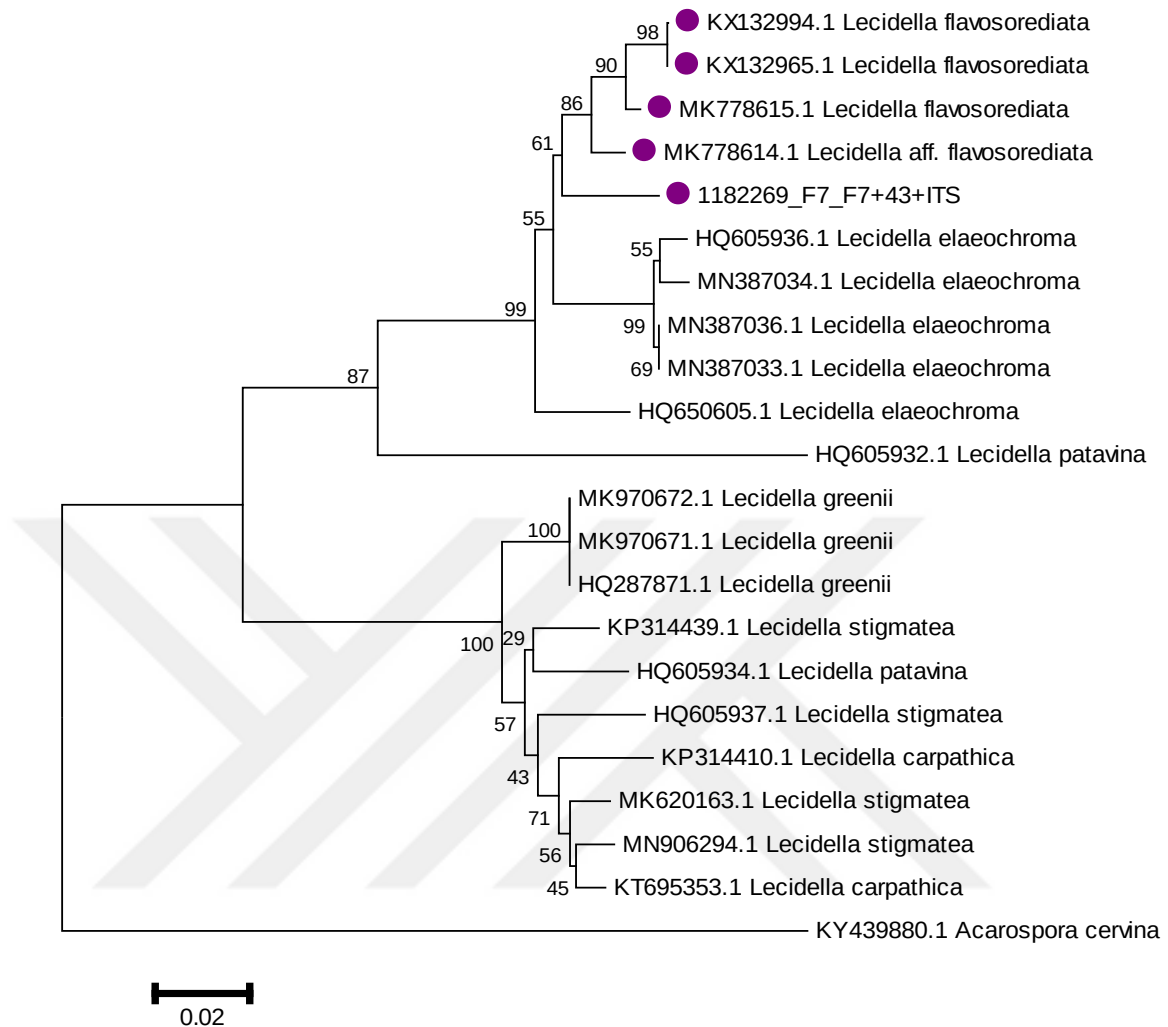


**Figure 4.25.** Neighbour-Joining dendrogram of *Lecidella flavosorediata* and related species (MAR 0.043).

#### 4.1.16. *Physcia adscendens* H. Olivier

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, alt. 200 m, 29 November 2019, [MAR 0.014].

**Description:** Thallus pale gray to pale greenish gray. Soredia, lobes mostly under 1 mm wide except for the helmets. Apothecia not common. Chemistry, Medulla K-.

**Substrate and ecology:** On bark, less frequently on rock. The lichen sample (MAR 0.014) we collected is found on siliceous rocks [58].

**World distribution:** widely distributed in temperate and boreal areas in all continents.

**Notes:** This is the only clearly “hooded” *Physcia*. *Physcia tenella* (Scop.) DC., a common bark-dwelling, ciliate lichen along both coasts, has lip-shaped soralia on the lobe tips but does not form hollow hoods or helmets [58].



**Figure 4.26.** *Physcia adscendens*. Thallus.

#### 4.1.17. *Physcia dubia* (Hoffm.) Lettau

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, alt. 200 m, 29 November 2019, [MAR 0.013].

**Description:** Thallus pale to dark ashy gray or sometimes yellowish gray, surface spotted with white maculae or almost uniform in color, sometimes with a light frosting of pruina on the lobe tips. Lobes, 0.3-1.2 (-3) mm wide, convex, fanning out at the tips, with abundant gray to greenish soredia produced under the turned-up lobe tips clearly visible. Apothecia rare. Chemistry, Medulla K-.

**Substrate and ecology:** On rocks of all kinds, wood and occasionally bark in open or partially shaded sites. The lichen sample (MAR 0.013) we collected is found on siliceous rocks [58].

**World distribution:** Northern Hemisphere and South America.

**Notes:** *Physcia callosa* Nyl. is a larger species on rock with very granular soredia produced under down-rolled rather than upturned lobe tips. In *Physcia subtilis* Degel., the soredia are not produced in masses and the lobes are uniformly narrow, rarely exceeding 0.5 mm across [58].



**Figure 4.27.** *Physcia dubia*. Thallus and apothecia.

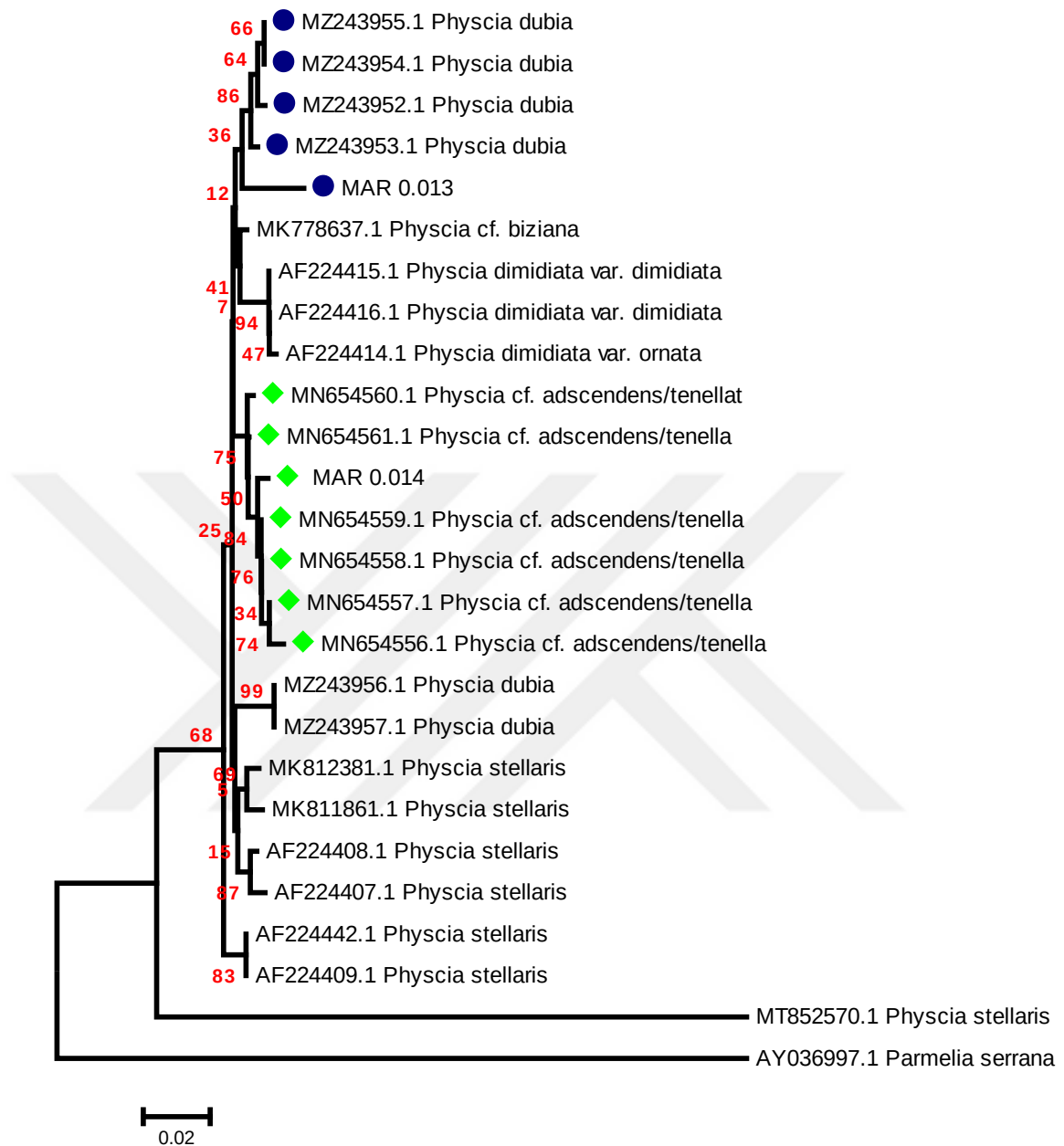


**Figure 4.28.** Neighbour-Joining dendrogram of *Physcia adscendens*-*Physcia dubia* and related species (MAR 0.013 and MAR 0.014).

**4.1.18. *Polyozosia dispersa* (Pers.) S.Y. Kondr., Lőkös & Farkas, in Kondratyuk, Lőkös, Jang, Hur & Farkas**

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, alt. 200 m, 29 November 2019, [MAR 0.018].

**Description:** Thallus usually growing between the rock crystals and absent from view. Apothecia 0.4-1.2 mm, crowded or dispersed, pale to dark yellow-brown or pinkish

brown, without pruina when mature, usually with prominent white margins. Ascospores ellipsoid,  $8.5-14 \times 3.5-7 \mu\text{m}$ . Chemistry, Pd-, K-, KC-, C-.

**Substrate and ecology:** On calcareous rocks, often seen on mortar or concrete, even in cities. The lichen sample (MAR 0.018) we collected is found on calcerous rocks [58].

**World distribution:** cosmopolitan species.

**Notes:** most frequent in urban areas (on monuments, mortar walls, asbestos-cement) up to the montane belt; records from natural habitats and from upland areas may refer to other species, especially to *Polyozosia semipallida* (H. Magn.) S.Y. Kondr., Lőkös & Farkas [58].



**Figure 4.29.** *Polyozosia dispersa*. Thallus and apothecia.

#### 4.1.19. *Polyozosia hagenii* (Ach.) S.Y. Kondr., Lőkös & Farkas, in Kondratyuk, Lőkös, Jang, Hur & Farkas

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Kefalos beach,  $40^{\circ} 07' 43.14''$  N,  $25^{\circ} 56' 35.32''$  E, alt. 200 m, 29 November 2019, [MAR 0.049].

**Description:** Thallus, endosubstratic. Apothecia, lecanorine, 0.3-0.6 mm across, with a pale to dark brown. Epithecium, yellowish brown. Hymenium, colourless, 40-60  $\mu\text{m}$  high. Paraphyses simple. Asci, 8-spored, clavate, *Lecanora*-type. Ascospores, 1-celled, hyaline, “ellipsoid, 8-13(-16)  $\times$  4-5(-7)  $\mu\text{m}$ . Photobiont chlorococcoid. Chemistry, Apothecial sections Pd-, K-, KC-, C-.

**Substrate and ecology:** on wide range of organic substrate (bark of trees, wood). The lichen sample (MAR 0.049) we collected is found on bark of trees [58].

**World distribution:** cosmopolitan on most continents.

**Notes:** It is very close to *P. dispersa* (Pers.) S.Y. Kondr., Lőkös & Farkas, in Kondratyuk, Lőkös, Jang, Hur & Farkas, a saxicolous lichen with largely non-pruinose and *Lecanora umbrina* Ehrh. ex Röhl. usually on wood, which has extremely crowded apothecia with thin, often disappearing margins and discs that are sometimes pruinose and sometimes not. *Polyozosia sambuci* (Pers.) S.Y. Kondr., Lőkös & Farkas is another similar rim-lichen on bark, especially poplars. It has very small apothecia (0.2-0.5 mm in diameter) and most important, 12-32 spores per ascus [58].



**Figure 4.30.** *Polyozosia hagenii*. Thallus and apothecia.

#### 4.1.20. *Polyozosia schofieldii* (Brodo) S.Y. Kondr., Lőkös & Farkas

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada- Eşelik highway, West of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.002].

**Description:** Thallus relatively thick, pale grey to yellowish grey or yellowish white. Apothecia lecanorine, 0.3– 0.6 mm in diameter, grey- or red-brown. Epihymenium

granular, yellow-brown to dark brown. Hymenium 45–55  $\mu\text{m}$  high, hyaline, amyloid. Hypothecium colourless, 90–100  $\mu\text{m}$  thick. Asci club-shaped, Lecanora-type. Ascospores hyaline, non-septate, 9.0–12.4  $\mu\text{m}$  4.8–6.2  $\mu\text{m}$ , length to width ratio variable, 8 per ascus. Thallus medulla PD–, K–, C–, KC–.

**Substrate and ecology:** Growing on calcareous or noncalcareous shoreline rocks [64]. The lichen sample (MAR 0.018) we collected is found on calcerous rocks.

**World distrubition:** Canada, Pacific Northwest.



**Figure 4.31.** *Polyozosia schofieldii* thallus and apothecia.

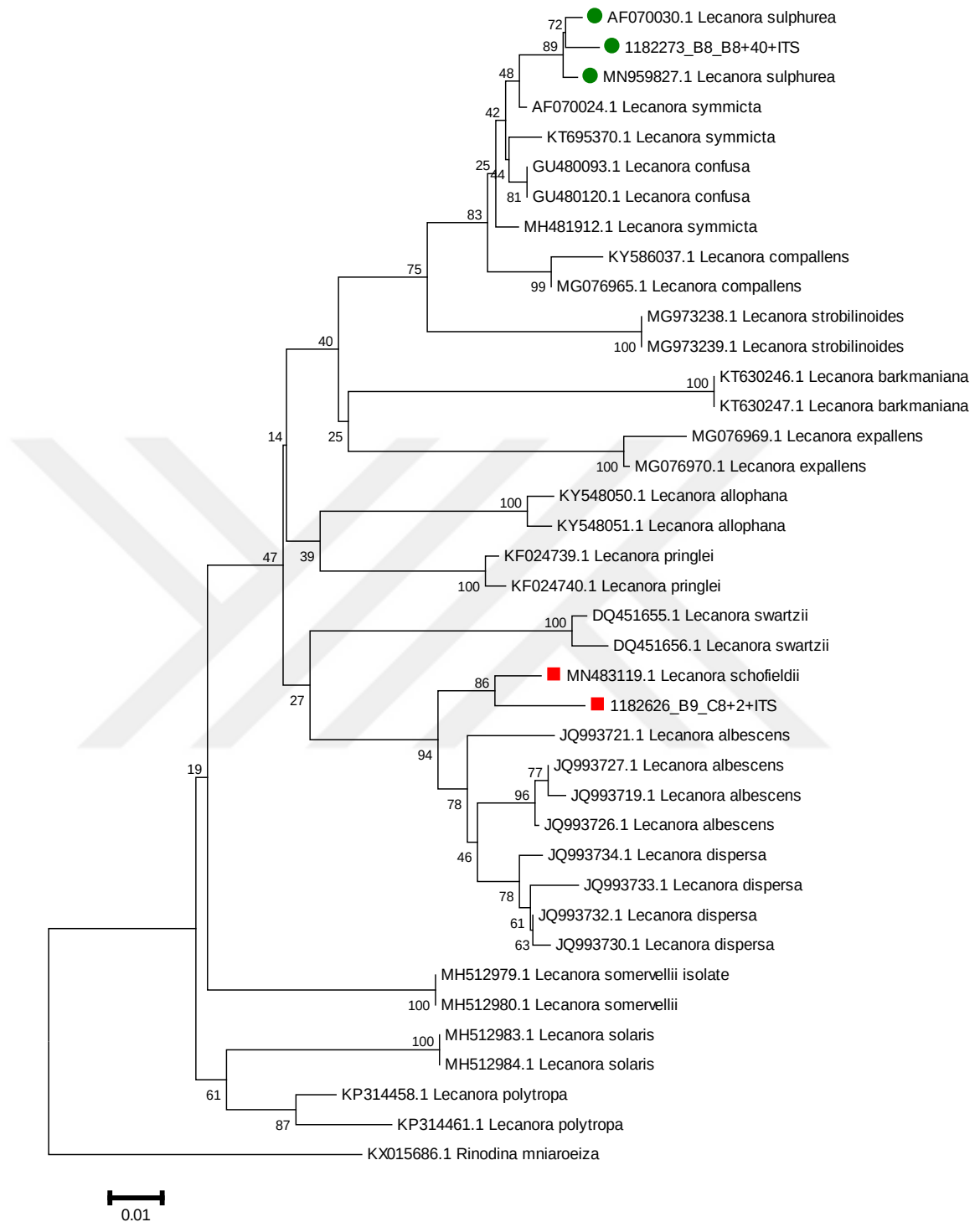


**Figure 4.32.** Neighbour-Joining dendrogram of *Glaucomaria sulphurea*-*Polyozosia schofieldii* and related species (Respectively, MAR 0.040 and MAR 0.002).

#### 4.1.21. *Protoparmelia montagnei* (Fr.) Poelt & Nimis

**Specimens studied:** Turkey, Çanakkale, Gökçeada, West of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.039 and MAR 0.042].

**Description:** Thallus crustose, continuous, very variable, thin and rimose-areolate or areolate, to thick, strongly warted to bullate or even subsquamulose, from (0.25- )0.75-1.5(-2.5) mm thick; usually chestnut-brown to grey-brown or reddish (coppery)-brown, ± dark brown, sometimes pale grey, cream, olivaceous or brownish black. Cortex 20-30(-40); algal layer, 60-100 µm, algal cells c. 10 µm in diam. Apothecia usually scattered, rarely numerous and crowded, sometimes absent, lecanorine, immersed to adnate or sessile and constricted at the base, round to flexuose or subangular when crowded, (0.5-)0.75-1.75(-2.5) mm in diam.; disc pale brown, chestnut brown to dark reddish brown, rarely brownish black, concave, plane to very convex, Epithymenium diffusely yellowish brown to dark brown, 20-30 µm thick, covered by a layer which is continuous with the epinecral layer of the thalline margin. Hymenium hyaline or yellowish, (50- )60-70(-90) µm tall, ± interspersed with elongated or granulose crystals except in chemotype IV. Asci clavate, 40-60 x 12-15 µm, ± Lecanora-type, with an ocular chamber and a distinct non-amyloid apical cushion, 8-spored. Ascospores hyaline, simple, (7.5-)9.5-13(-16) x (2.5-)3-4(-4.5) µm. Pycnidia always present, usually very abundant, immersed, ostiole dark brown to black, punctiform, in section globose to oblong, wall brown-pigmented only around the ostiole.

**Substrate and ecology:** on siliceous rocks. The lichen samples (MAR 0.039 and MAR 0.042) we collected is found on siliceous rocks.

**World distribution:** Europe, North Africa, Atlantic coast of the Iberian Peninsula.

**Note:** The type specimens of *Protoparmelia montagnei* (Fr.) Poelt & Nimis and *P. psarophana* (Nyl.) Sancho & A. Crespo are macroscopically very similar. The main differences observed are in the colour and surface of the thallus and in the attachment of the apothecia. Thus the upper surface of *P. montagnei* is chestnut-glossy, composed of convex to warted areolae and having sessile, constricted apothecia. The upper surface of *P. psarophana* on the other hand is grey-brown, mottled and mat, being composed of flat to uneven areolae with adnate apothecia. Neither of the type specimens has marginal thalline lobes, which is a distinguishing character according to several authors.

Furthermore, except for the presence/absence of crystals in cortices, the two type specimens are indistinguishable microscopically [58].



**Figure 4.33.** *Protoparmelia montagnei* thallus and apothecia on siliceous rock.

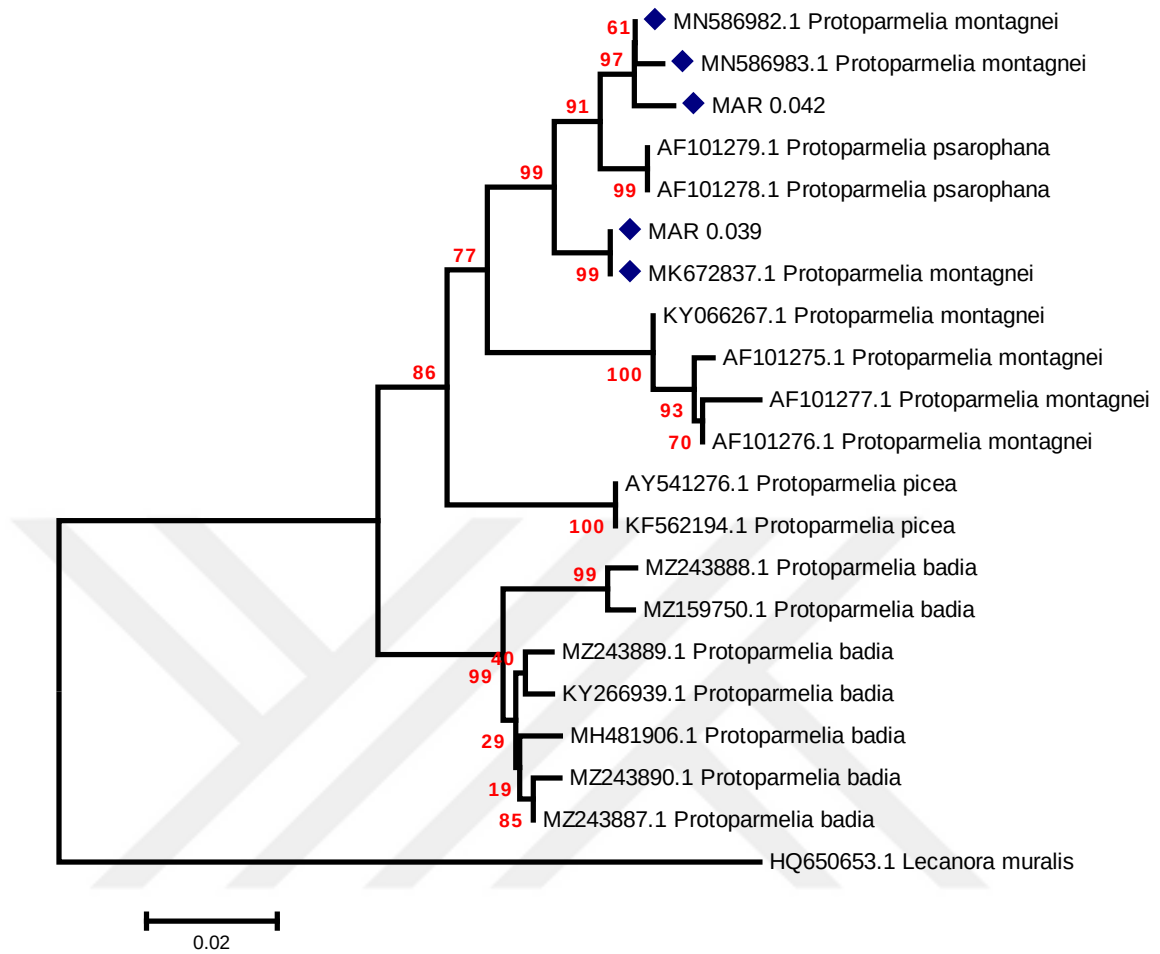


**Figure 4.34.** Neighbour-Joining dendrogram of *Protoparmelia montagnei* and related species (MAR 0.039 and MAR 0.042).

#### 4.1.22. *Protoparmeliopsis muralis* (Schreb.) M. Choisy

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, stepe vegetation, 40° 08' 21.00" N, 25° 56' 42.77" E, 29 m, 28 November 2019, [MAR 0.031].

**Description:** Thallus waxy, light yellowish green with little or no pruina; coastal forms often very pale; areolate in the center of the thallus, becoming lobed at the margins, sometimes squamulose. Marginal lobes very flat, closely appressed, 0.3-0.6 mm wide. Lobe edges often pale but can also be blackish and somewhat raised. Medulla loose and cottony rather than dense and solid. Apothecia yellow to red-brown, not pruinose, with rather thick, persistent, thallus-colored margins, 0.5-2.3 mm in diameter. Ascospores 9-15 x 4.5-7 µm. Chemistry, Cortex KC+ gold; medulla Pd-, K-, C-, KC-.

**Substrate and ecology:** On all kinds of rock including cement and mortar, rock walla and stone fences. The lichen sample (MAR 0.031) we collected is found on siliceous rocks.

**World distribution:** Europe, Asia, North America, South America, Africa and Australasia.

**Notes:** This is one of the most common and widespread lobed species of *Lecanora*. *Lecanora valesiaca* (Müll. Arg.) Stizenb. is very similar, but the thallus is heavily pruinose. It is widespread throughout North America. *Protoparmeliopsis bipruinosa* (Fink) S.Y. Kondr. is a southwestern desert species with patches of pruina on the lobes and pruinose apothecia. One example is *Polyozosia straminea* (Ach.) S.Y. Kondr., Lőkös & Farkas, which often accompanies *P. muralis* (Schreb.) M. Choisy on bird rocks along the West coast. It has large shiny brown apothecia crowding the center of the thalli and the marginal lobes are thick and almost foliose [58].



**Figure 4.35.** *Protoparmeliopsis muralis*. Thallus and Apothecia.

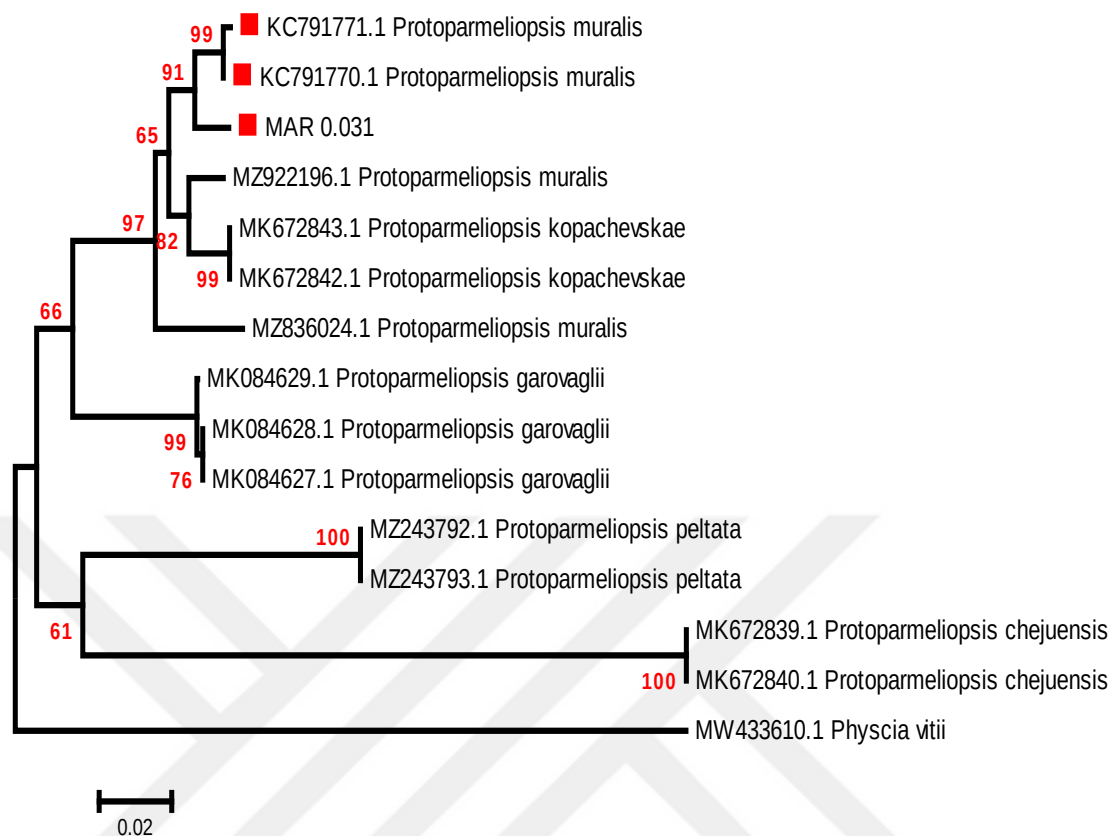


**Figure 4.36.** Neighbour-Joining dendrogram of *Protoparmeliopsis muralis* and related species (MAR 0.031).

#### 4.1.23. *Pyrenodesmia albolutescens* (Nyl.) S.Y. Kondr.

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vegetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November. 2019, [MAR 0.020].

**Description:** The thallus is a very thin white layer, especially in the central part, covered with irregular grayish sores. The cortex is undeveloped. Apothecia red to brownish-red, zeorin, disc almost blackish red, inner margin lighter, outer margin below, thinner and yellowish-white, (0.35–)0.4–0.6–0.8(–1) mm in diameter. Paraphyseal tips 3.5–5 µm in diameter. Ascospores (14.5–)15.5–17–18.5(–20) × (7–)8–9–10(–10.5) µm, septa (3–)3.2–4–4.8(–5) µm. Ascospore length/width ratio (1.5–)1.7–1.9–2.1(–2.4), septa/length ratio (0.33–)0.37–0.45–0.53(–0.58).

**Substrate and ecology:** on calceorus and siliceous rocks. The lichen sample (MAR 0.020) we collected is found on calcerous rocks.

**World distribution:** Europe, North America.

**Notes:** The most morphologically similar species is related to *Caloplaca teicholyta*, which also grows on calcareous rocks. Both species have lime-white thallus with densely vegetative diaspores in the centers of their thalli, but *C. teicholyta* is much thicker, well developed and has prominent lobes on the margin, while *C. albolutescens* has a very thin thallus without marginal lobes [65].



**Figure 4.37.** *Pyrenodesmia albolutescens*. Apothecia and thallus.

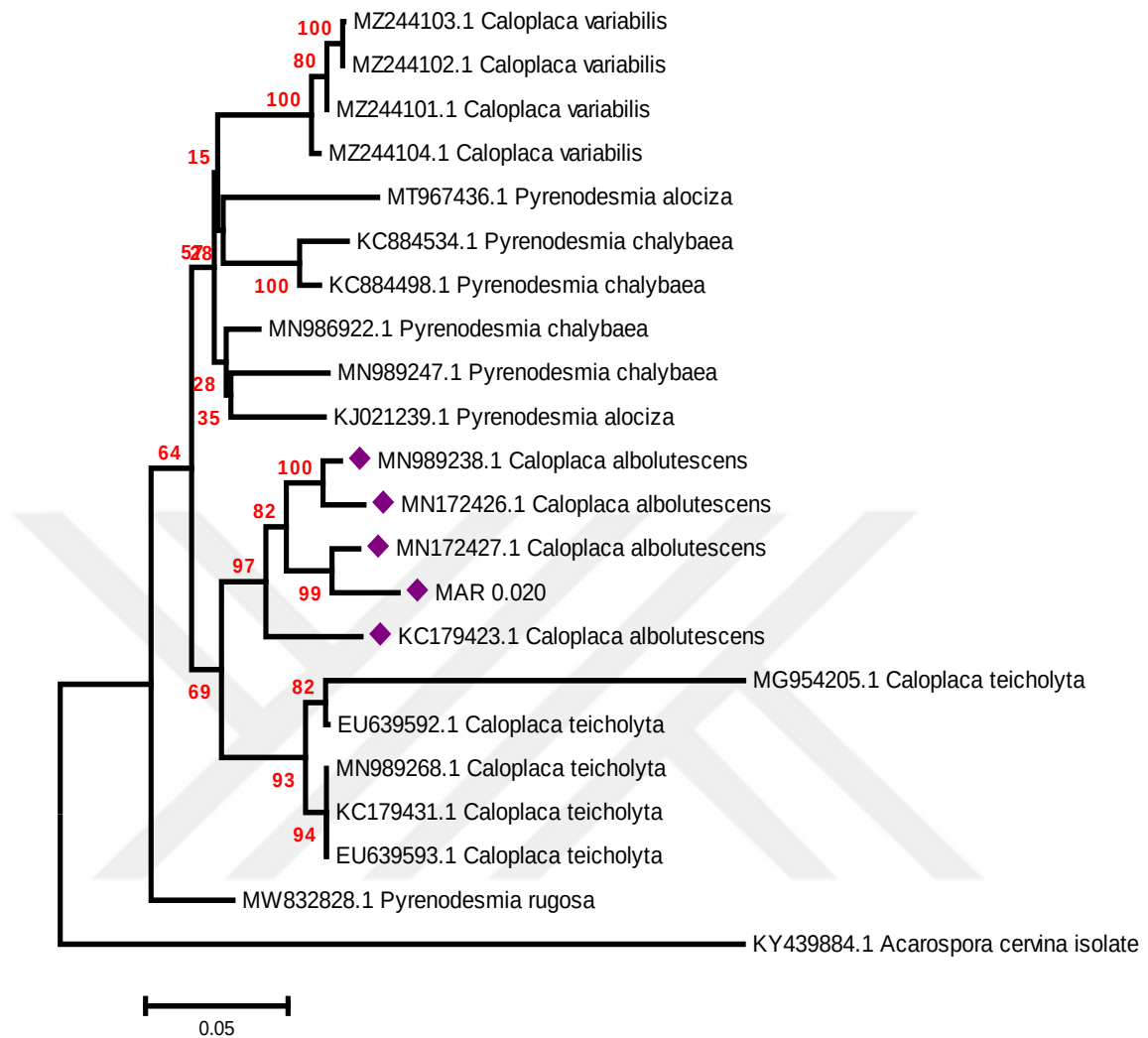


**Figure 4.38.** Neighbour-Joining dendrogram of *Pyrenodesmia albolutescens* and related species (MAR 0.020).

#### 4.1.24. *Pyrenodesmia variabilis* (Pers.) A. Massal.

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vegetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November. 2019, [MAR 0.047].

**Description:** Thallus, crustose, areolate, gray or White. Apothecia, 0.3-1 mm in diam, dark brown or black, flat. Epihymenium, light brown or gray, K<sup>+</sup> violet. Hymenium, hyaline. Paraphyses, 1-2 tip cells. Asci, cylindrical, 8-spored. Ascospores, hyaline, 2 locules, ellipsoid, 12.5-15.5(-17) x 7-8.5(-9.5) µm, isthmus 3-3.5(-4) µm, spore end wall thin. Chemical tests, K<sup>+</sup> violet.

**Substrate and ecology:** On calceorus rocks. The lichen sample (MAR 0.047) we collected is found on calcerous rocks.

**World distribution:** Europe and North America.

**Notes:** *Pyrenodesmia variabilis* (Pers.) A. Massal. is thallus gray and pruinose. The epihymenium and thallus are K+ violet [58].



**Figure 4.39.** *Pyrenodesmia variabilis*. Thallus and apothecia.

#### 4.1.25. *Ramalina breviscula* Nyl.

**Specimens studied:** Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.033 and MAR 0.044].

**Description:** Thallus shrubby, typically small tufts forming, 1-3 cm diam., 0.5-2.5 cm high, erect owing to some branches, strap-shaped, 1-5 mm wide and 0.5-3 cm long, apices more or less broadened, irregular, pointed or minute hook-shaped, grey-greenish when moist, grey-yellowish to greenish when dry. Apothecia absent to numerous, at branch apices, bowl-shaped, from shallow to deep, disc concolourous to the thallus, or

slightly paler, exciple not sorediate. Colorless ascospores, 1-septate, sometimes slightly curved or kidney-shaped, 9-16 x 4-6  $\mu\text{m}$  according to the literature, 10-14 (15) x 4-6  $\mu\text{m}$  according to our measurements. C-, K-, KC-, Pd-. Mediterranean, on acid rocks near the seashore, seldom inland.

**Substrate and ecology:** On coastal siliceous rocks. The lichen samples (MAR 0.033 and MAR 0.044) we collected is found on siliceous rocks.

**World distribution:** Europe.

**Notes:** Appears like *Ramalina fastigiata* (Pers.) Ach. but the latter is larger, with wider branches and tightly corticolous (very seldom saxicolous on alkaline rocks) [58].



**Figure 4.40.** *Ramalina breviuscula*.

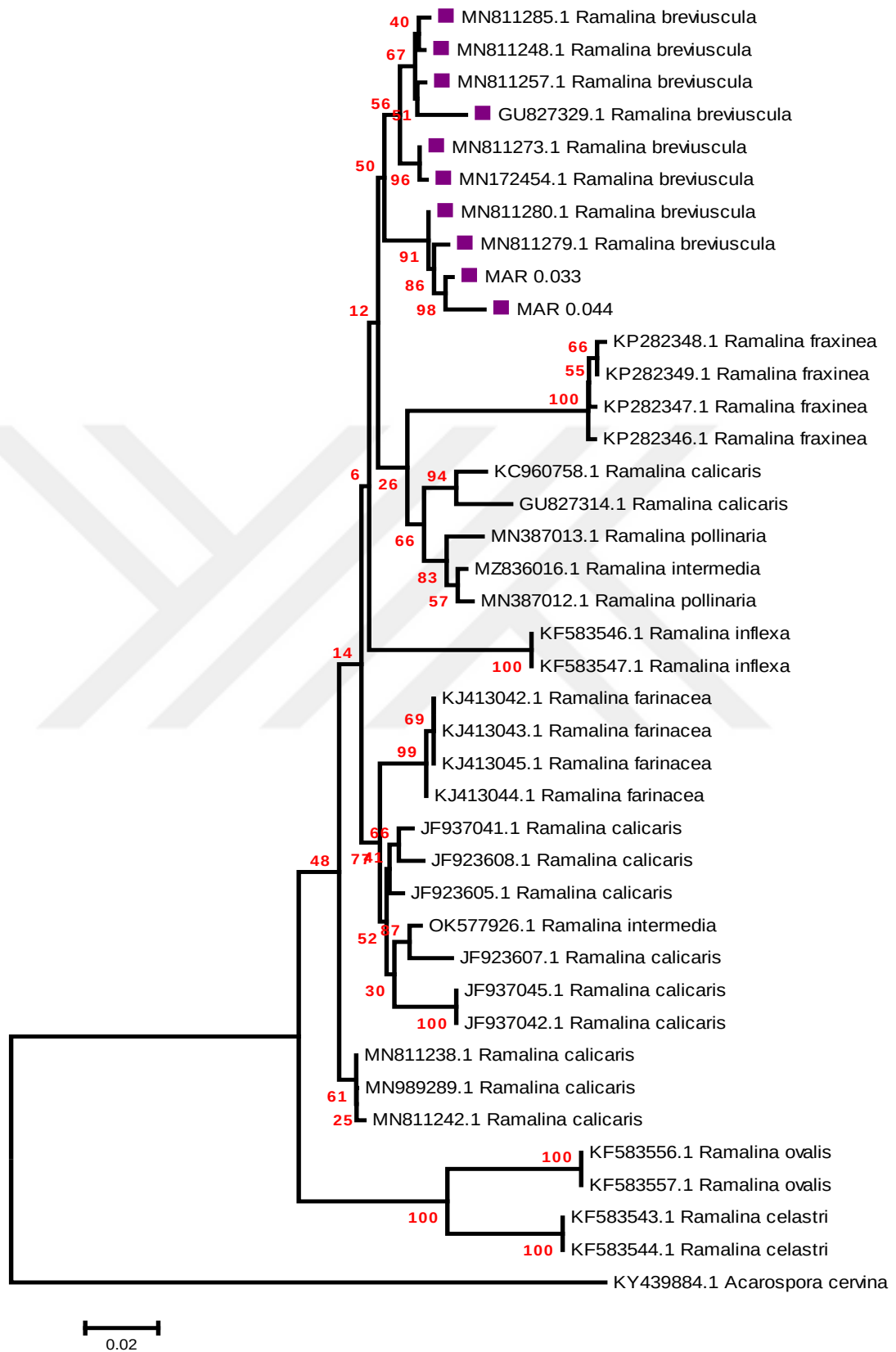


**Figure 4.41.** Neighbour-Joining dendrogram of *Ramalina breviscula* and related species (MAR 0.033 and MAR 0.044).

#### 4.1.26. *Rhizocarpon atroflavescens* Lynge

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, 200 m, 29 November 2019, [MAR 0.011].

**Description:** Thallus crustose, yellowish white to white. Apothecia frequent, lecideine, rounded, 0.3-1.5 mm across, with a black. Epithecium reddish brown, K+ red. Hymenium colourless, 90-150 µm high. Hypothecium brown, 100-300 µm high, K-. Asci 8-spored, clavate, *Rhizocarpon*-type. Ascospores 1-4-septate, dark green to brown, ellipsoid, 10-24 x 6-10 µm. Spot tests, medulla K-, C-, KC-, P- or P+ yellow.

**Substrate and ecology:** on siliceous rocks. The lichen sample (MAR 0.011) we collected is found on siliceous rocks.

**World distribution:** Europe.

**Note:** a cool-temperate to arctic-alpine, perhaps circumpolar species found on steeply inclined surfaces of base-rich, or weakly calciferous siliceous rocks near or above treeline; common and certainly more widespread in the Alps, rare in the Apennines; the record from Abruzzo is the southernmost one in Europe [58].



**Figure 4.42.** *Rhizocarpon atroflavescens*. Thallus.

#### 4.1.27. *Rhizocarpon geminatum* (Körb)

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, 200 m, 29 November 2019, [MAR 0.012].

**Description:** Thallus, crustose. Apothecia, black, adnate. Epihymenium, brown to brownish black. Hymenium, hyaline, 100-140 µm tall. Hypothecium, brown. Asci, clavate, 2-spored. Ascospores, pale green, ellipsoid, 35-60 x 18-28 µm. Pycnidia, frequent, black, almost globose. Spot tests, medulla K<sup>+</sup> weak yellow. Secondary metabolites, rhizocarpic, stictic and norstictic acids.

**Substrate and ecology:** on siliceous rocks. The lichen sample (MAR 0.012) we collected is found on siliceous rocks.

**World distribution:** North America and Greenland, Europe and South America.

**Note:** a widespread lichen of dry continental areas, found on steeply inclined faces of base-rich or weakly calciferous siliceous rocks both in natural and man-made substrate. A chemically heterogeneous species, may represent a special taxon [58].



**Figure 4.44.** *Rhizocarpon geminatum* Thallus and apothecia.

#### 4.1.28. *Rinodina gennarii* Bagl.

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vegetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November 2019, [MAR 0.019].

**Description:** Thallus, crustose, up to 0.2-0.7 mm wide, dark gray to gray-brown. Apothecia, adnate, up to 0.25-0.6(-0.8) mm in diam., black, plane. Hymenium: 70-90 µm tall. Paraphyses, 1.5-2.5 µm wide. Hypothecium, hyaline, 30-70 µm

thick. Asci, clavate, 40-60 x 12-19  $\mu\text{m}$ , 8-spored. Ascospores, brown, 1-septate, broadly ellipsoid, Dirinaria-type, 11-18 x 6-9  $\mu\text{m}$ . Spot tests: all negative.

**Substrate and ecology:** frequent on maritime rocks and on eutrophic rocks. The lichen sample (MAR 0.019) we collected is found on siliceous rocks.

**World distribution:** Northern and Southern Hemispheres, Europe.

**Notes:** *Rinodina gennarii* Bagl. is remarkable for the degree of variability" shown by its thallus morphology and spore size. The thallus, that may be evanescent, is usually continuous or rimose with a scabrid appearance, but may also be well developed with verrucose areoles [58].

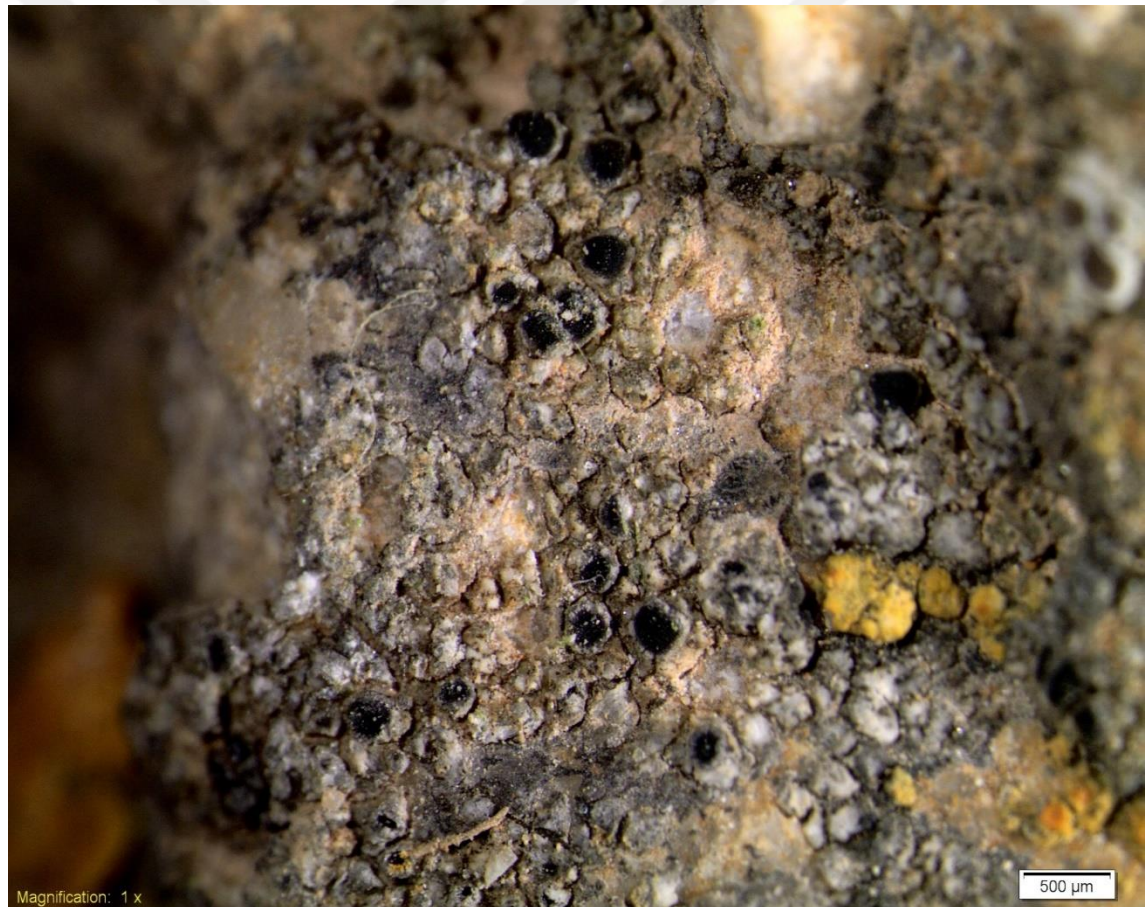


**Figure 4.45.** *Rinodina gennarii*. Thallus and apothecia.

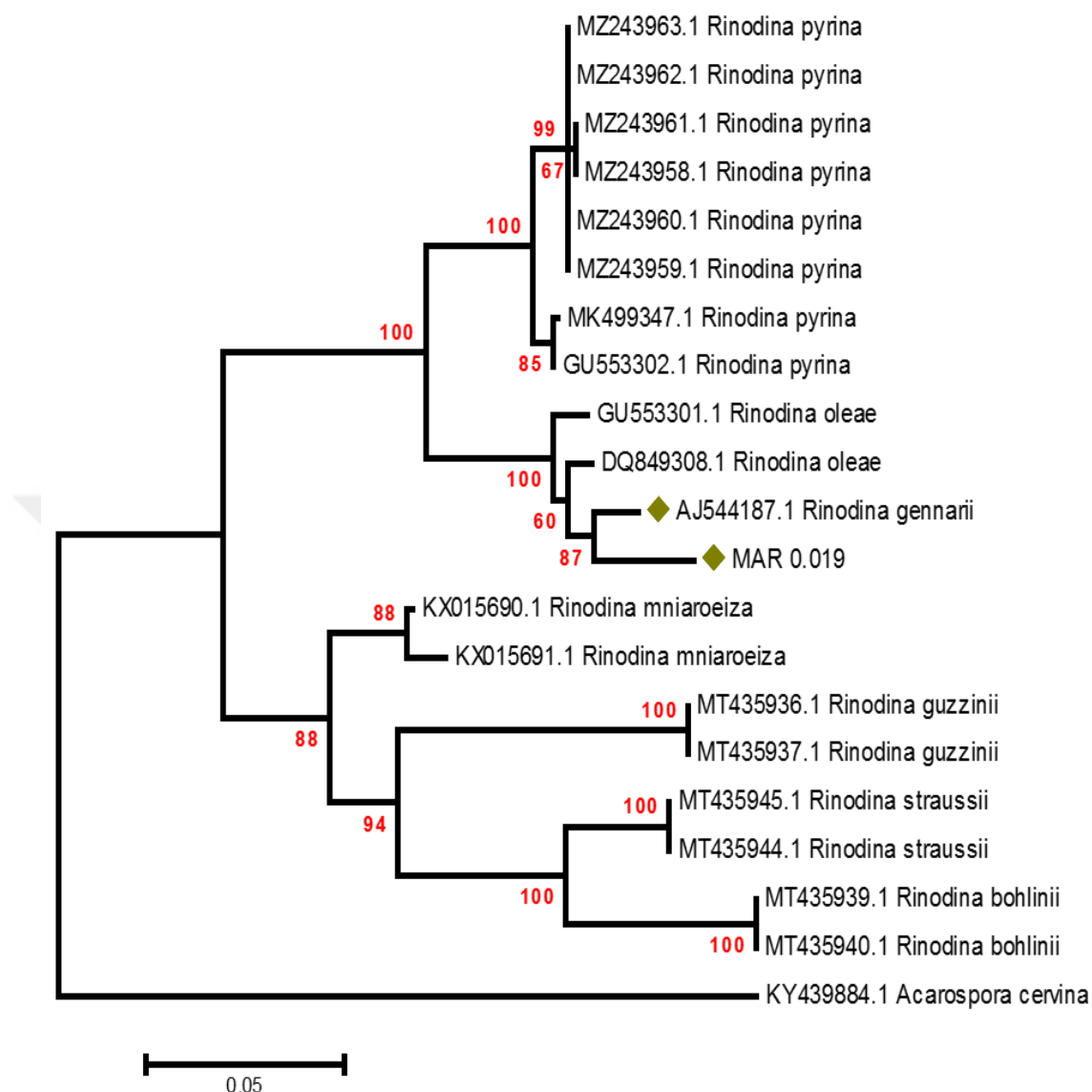


**Figure 4.46.** Neighbour-Joining dendrogram of *Rinodina gennarii* and related species (MAR 0.019).

#### 4.1.29. *Rinodina oleae* Bagl.

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vegetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November 2019, [MAR 0.030].

**Description:** Thallus crustose, 0.2–0.7 mm wide, whitish, pale to dark grey or yellow-brown. Apothecia 0.2–0.6 mm wide, dark brown to black, plane to convex. Epithymenium 5–15 µm thick, brown. Hymenium 60–110 µm thick, colourless. Hypothecium 50–150 µm thick, colourless, K–. Asci 8-spored. Ascospores Dirinaria-

type grading into *Physconia*-type, 1-septate, brown, ellipsoidal,  $11.0\text{--}18.5 \times 6\text{--}11\text{ }\mu\text{m}$ ; Chemistry, Thallus K–, C–, P–.

**Substrate and ecology:** Common on siliceous rocks or, more rarely, on concrete, bark or wood. The lichen sample (MAR 0.030) we collected is found on calcereous rocks.

**World distribution:** Southern and eastern Australia, Europe, Asia, Africa, North and South America, New Zealand and the Pacific.

**Notes:** *Rinodina oleae* Bagl. is characterised by the whitish, pale to dark grey or yellow-brown thallus, the *Dirinaria*-type ascospores and the absence of lichen substances [58].



**Figure 4.47.** *Rinodina oleae* thallus and apothecia on calcareous rock.

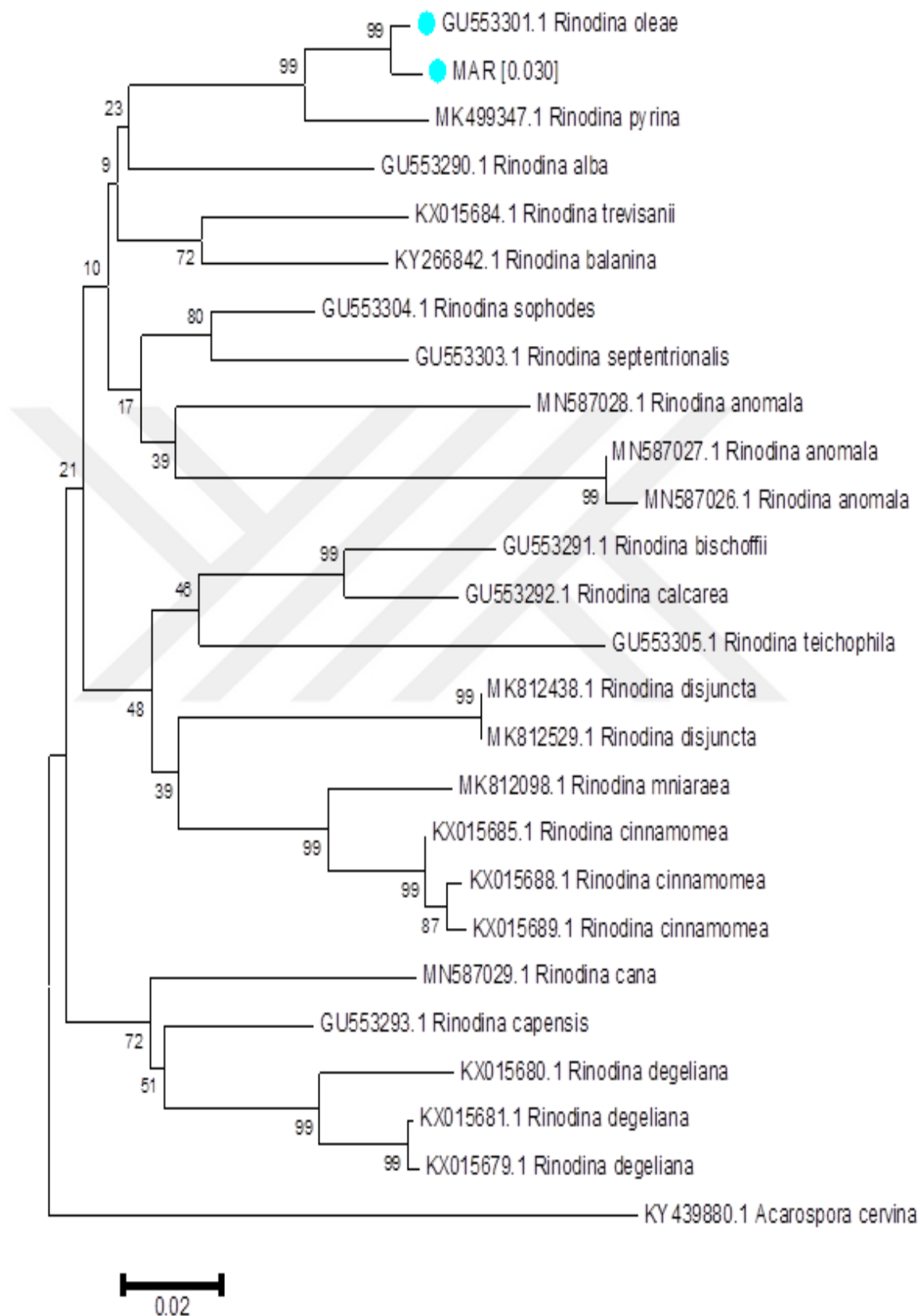


**Figure 4.48.** Neighbour-Joining dendrogram of *Rinodina oleae* and related species (MAR 0.030).

#### 4.1.30. *Rinodina pyrina* (Ach.) Arnold

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, stepe vegetation, 40° 08' 49.79" N, 25° 56' 37.03" E, 32 m, 28 November 2019, [MAR 0.008].

**Description:** Thallus, crustose, up to 0.2-0.3 mm wide, light or dark gray. Apothecia, adnate, up to 0.3- 0.5 mm in diam., dark brown becoming black. Hymenium, 55-80 µm tal. Paraphyses, 2-3 µm wide. Hypothecium, hyaline. Asci, clavate, 35-55 x 11-15 µm, 8-spored. Ascospores, brown, 1-septate, Physconia-type, 10-15 x 5-7 µm. Pycnidia, immersed in thallus" conidia: bacilliform, 4-6 x 1-1.5 µm. Spot tests, all negative.

**Substrate and ecology:** On bark. The lichen sample (MAR 0.008) we collected is found on bark.

**World distribution:** Europe, Asia, northern Africa, Australasia, and North America.

**Notes:** *Rinodina pyrina* (Ach.) Arnold is characterized by its gray thallus, crowded and usually convex apothecia, and its small, Physconia-type spores [58].



**Figure 4.49.** *Rinodina pyrina*. Thallus and Apothecia.

#### 4.1.31. *Rinodina roboris* (Dufour ex Nyl.) Arnold

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.038].

**Description:** Thallus, crustose, up to 0.4-0.8 mm diam. Apothecia, sessile, up to 0.7-0.8 mm in diam., light to dark brown. Hymenium, 70-110 µm tall. Asci, clavate, 50-65 x 18-22 µm, 8-spored. Ascospores, brown, 1-septate, ellipsoid, Pachysporaria-type, 17-25 x 9-13 µm, Secondary metabolites, atranorin in cortex.

**Substrate and ecology:** it occurs on rough barked trees, particularly *Quercus*. The lichen sample (MAR 0.038) we collected is found on siliceous rocks.

**World distribution:** Europe and Mexico.

**Notes:** *Rinodina roboris* (Dufour ex Nyl.) Arnold is characterized by its thick thallus with atranorin in the cortex, large apothecia with flexuose margins, and Pachysporaria-type spores [58].



**Figure 4.50.** *Rinodina roboris*. Thallus and apothecia.

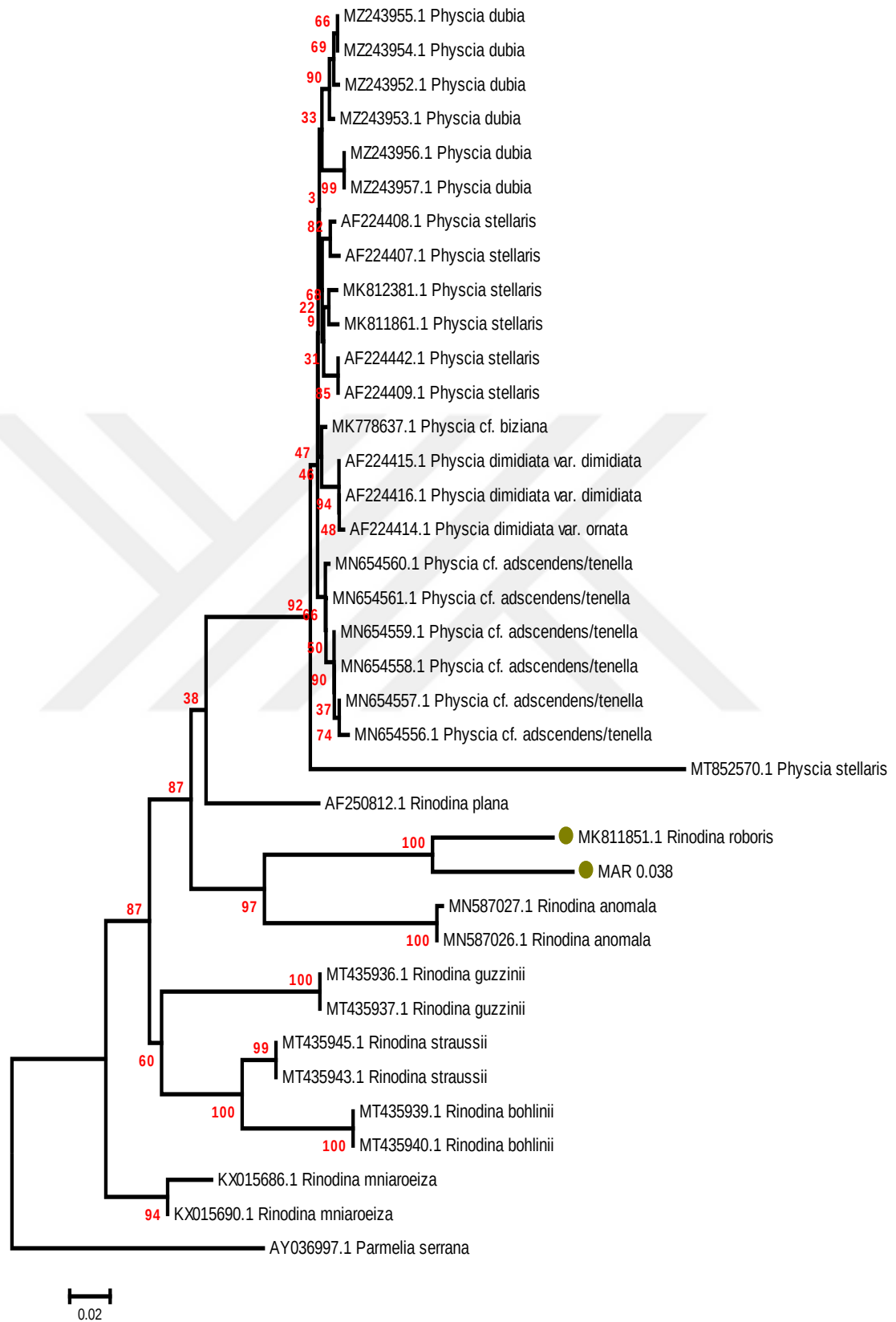


**Figure 4.51.** Neighbour-Joining dendrogram of *Rinodina roboris* and related species (MAR 0.038).

#### 4.1.32. *Sarcogyne regularis* Körb.

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Weast of Salt Lake, North of Kefalos beach 40° 08' 05.03" N, 25° 56' 44.31" E, 21 m, 05 October 2021, [MAR 0.036].

**Description:** Thallus crustose, largely within the upper layers of rock, creating a thin White or pale gray to brownish gray stain, continuous and rimose. Apothecia lecideine, quite round, 0.5-1.5 (-2) mm in diameter, flat to slightly convex, sometimes partially immersed in the rock; discs rddish brown, lightly to heavily white pruinose; margin black, thin, even, raised and persistent or occasionally disappearing. Epihymenium brown. Hypothecium colorless, exciple black at edge but almost colorless within. Ascospores colorless, narrowly ellipsoid, 3-5 (-6) x 1.5-2  $\mu$ m, more than 100 per ascus. Chemistry, No lichen substances.

**Substrate and ecology:** On limy rocks, pebbles, cement and mortar, in exposed or somewhat shaded sites. The lichen sample (MAR 0.036) we collected is found on calcerous rock.

**World distribution:** Europe, North America, Asia, Africa, Greenland, and New Zealand.

**Notes:** It is common both in urban and in natural situations, mostly in lichen-poor stands, with a very wide altitudinal range; widespread throughout the Alps [58].



**Figure 4.52.** *Sarcogyne regularis*. Thallus and apothecia.

#### 4.1.33. *Tephromela atra* var. *calcareea* (Jatta) Clauzade & Cl. Roux

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, step vegetation, 40° 08' 21" N, 25° 56' 42.77" E, alt. 29 m, 28 November 2019, [MAR 0.003].

**Description:** Thallus creamy white to yellowish gray, often shiny, very thick and areolate when on rock, with smaller areoles when on wood and relatively thin and verruculose when on bark; without soredia or isidia; prothallus inconspicuous or absent. Apothecia pitch-black, shiny, with a thick or thin margin, thallus-colored or partially blackened like the disc, 0.7-0.3 mm in diameter; hymenium violet; hypothecium yellowish brown to golden yellow; Ascospores ellipsoid, 10-15 x 5-8 µm. Chemistry: Cortex Pd-, K + yellow, KC + yellow. Medulla: Pd-, K-, KC+ pink-violet, C-.

**Substrate and ecology:** On siliceous or nutrient-rich rocks, on wood and on bark. The lichen sample (MAR 0.003) we collected is found on siliceous rocks.

**World distribution:** Antarctica, Africa, Asia, Australasia, Europe, North and South America.

**Notes:** Two varieties of this common species are described:

*Tephromela atra* var. *calcareea* that grows on calcareous rocks.

*Tephromela atra* var. *torulosa* that grows on smooth bark of deciduous trees notably *Fagus*.

The var. *torulosa* differs from var. *atra* in the reduced size of the thallus and apothecia (<1 mm diam.); when fresh the thallus has a slight but distinct greenish hue. On trees especially branches of broad-leaved trees, occasional; very rare.

Two possible hypotheses may explain the low resolution between the Mediterranean *T. calcareea* and *T. atra* s.str. First, this pattern could indicate that no genetic adaptation to the different ecological circumstances is present, and the morphological differences between the two taxa are simply induced by the accumulation of calcium oxalates in limestone occurring thalli, as suggested by Salvadori and Tretiach (2002). Alternatively, the specialisation to the different substrates has not yet led to reciprocally isolated alleles in our investigated loci [66].



**Figure 4.53.** *Tephromela atra* var. *calcarea* thallus and apothecia.

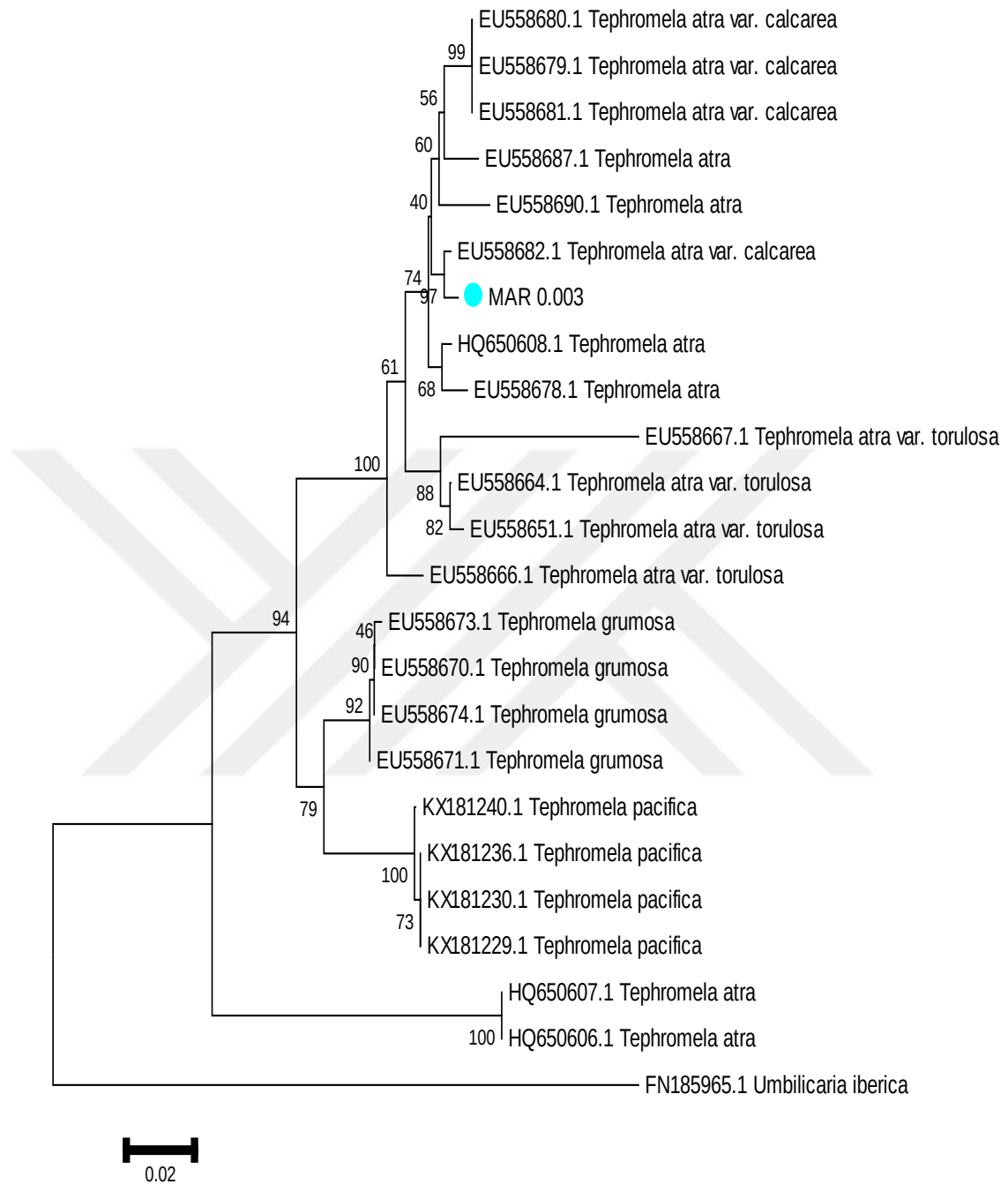


**Figure 4.54.** Neighbour-Joining dendrogram of *Tephromela atra* var. *calcarea* and related species (MAR 0.003).

#### 4.1.34. *Toninia talparum* Timdal

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, stepe vegetation, 40° 08' 21.00" N, 25° 56' 42.77" E, 29 m, 28 November 2019, [MAR 0.005].

**Description:** Life habit, not lichenized, lichenicolous. Thallus, absent. Apothecia, up to 1 mm diam., remaining  $\pm$  plane and marginate or plane and marginate when young, later convex and immarginate, epruinose. Exciple, greenish brown in rim, usually paler in inner part. Hypothecium, pale brown to colorless. Epithecium, bright to dark green (K-, N+ violet). Asci, clavate, 8-spored. Ascospores, ellipsoid, 1-septate, 10-14.5 x 4-5.5  $\mu$ m. Pycnidia, not seen. Secondary metabolites, none detected. Host, *Lecania*.

**Substrate and ecology:** on siliceous rocks. The lichen sample (MAR 0.005) we collected is found on siliceous rocks.

**World distribution:** Europe, North America.

**Notes:** According to the protologue, *T. talparum* Timdal develops apothecia up to 1 mm diam. Three lichenicolous *Toninia* species may occur on saxicolous hosts. *Toninia subfuscae* (Arnold) Timdal differs in having larger apothecia (up to 0.6 mm) and 1–3-septate spores, and it grows on other crustose lichens of the Lecanoraceae such as *Lecanora campestris*, *L. chlarotera*, *L. muralis*, *L. sienae*, *L. horiza*, *Lecanora* sp. and *Lecidella scabra*. *Toninia subtalparum* P.Boom, another species on *Lecania*, resembles *T. talparum* but is only known from *L. dudleyi* (Sonoran region) and differs” in having longer and wider ascospores, a dark brown hypothecium and a reddish brown excipulum [66].



**Figure 4.55.** *Toninia talparum* thallus and apothecia.

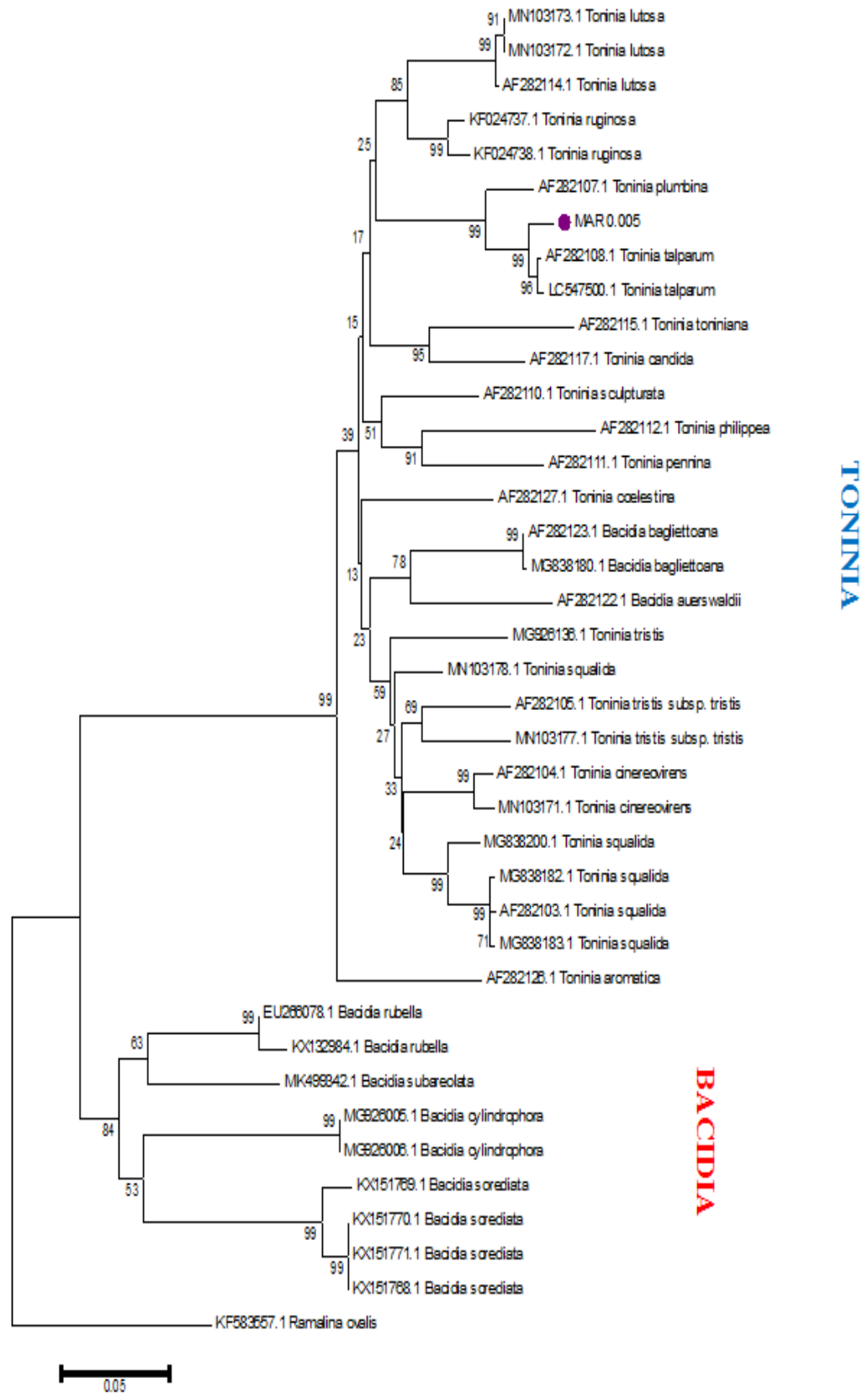


**Figure 4.56.** Neighbour-Joining dendrogram of *Toninia talparum* and related species (MAR 0.005).

#### 4.1.35. *Variospora aegaea* (Sipman) Arup, Frödén & Söchting

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, steep vegetation, 40° 08' 21.00" N, 25° 56' 42.77" E, 29 m, 28 November 2019, [MAR 0.001].

**Description:** Thallus saxicolous, placodioid, yellowish to brownish orange. Apothecia frequent, rounded, c. 0.4-0.8 (-1.5) µm in diam. Hypothecium and excipulum colourless, excipulum with algal layer. Hymenium 60-70 µm, clear. Ascospores 8 per ascus, hyaline, polarilocular, citriform, 10-15 × 9-11 µm, with 4-5 µm thick septum. Chemistry, Thallus, apothecia K+ dark purple.

**Substrate and ecology:** On siliceous rocks. The lichen sample (MAR 0.001) we collected is found on siliceous rocks.

**World distribution:** It has been found in Paros, Antiparos and Kalimnos in the Aegean Sea, as well as Sardinia, Italy, and in southeastern Spain [58].

**Notes.** '*Variospora aegaea* (Sipman) Arup, Frödén & Söchting externally resembles *Calogaya saxicola* (Hoffm.) Vondrák most closely. It differs most clearly by the presence of citriform ascospores. The differentiation needs care, however, since the ascospores become citriform only in a late stage and in preparations the majority of the spores is often ellipsoid. The loosely appressed marginal lobes also help to separate the species [58].

The other placodioid species of *Caloplaca* in Europe with citriform spores, *C. aurantia* (Pers.) J. Steiner, *C. flavescens* (Huds.) J. R. Laundon and *C. thallincola* (Weddell) Du Rietzm differ by the following characters: *C. aurantia* has flat, closely appressed, usually wider marginal lobes, often with white-pruinose zones; it resembles *C. aegaea* in colour. *C. flavescens* and *C. thallincola* have longer and more strongly convex, closely appressed marginal lobes with a yellowish colour, the first sometimes with white-pruinose zones [58].



**Figure 4.57.** *Variospora aegaea* thallus and apothecia.

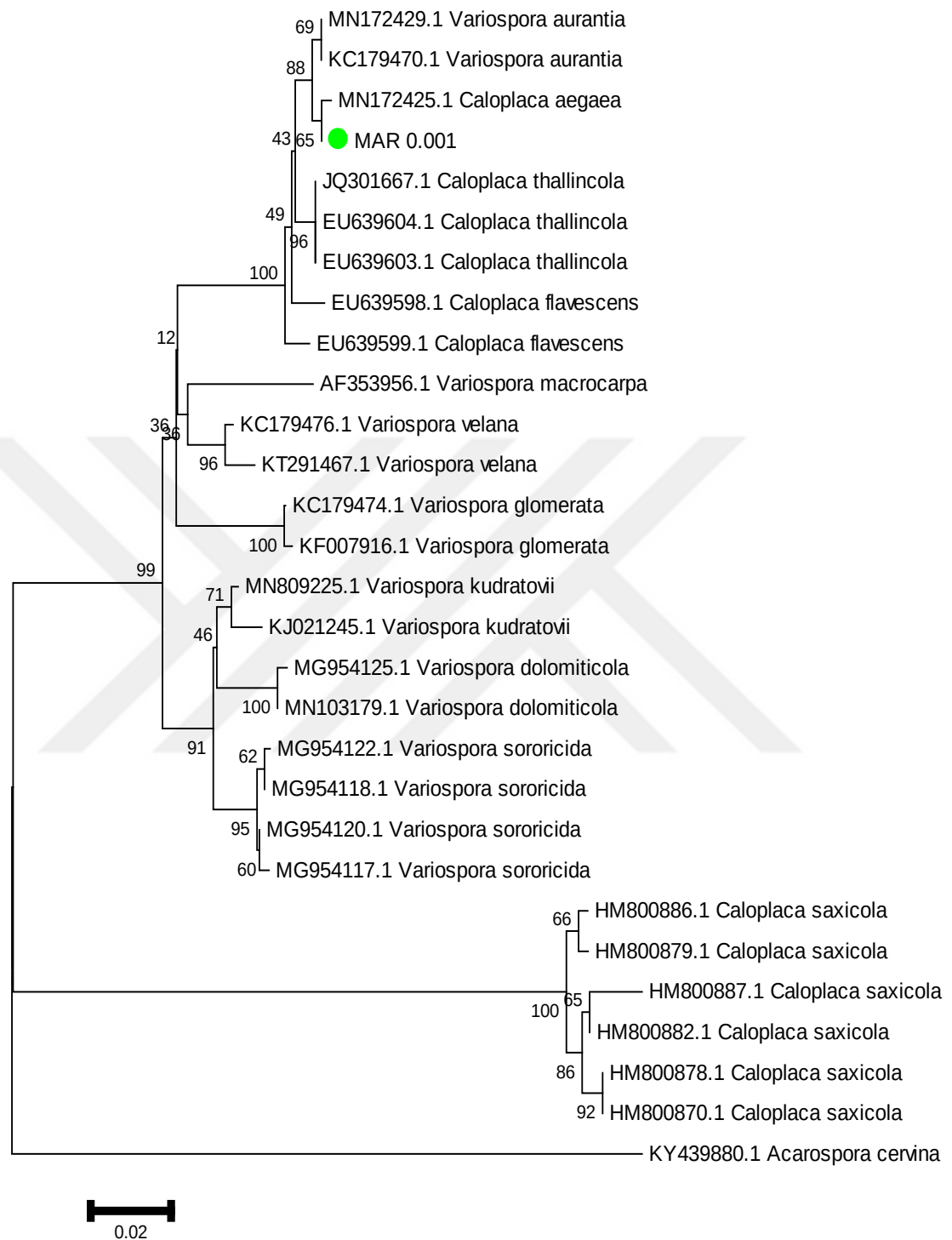


**Figure 4.58.** Neighbour-Joining dendrogram of *Variospora aegaea* and related species (MAR 0.001).

#### 4.1.36. *Variospora dolomiticola* (Zahlbr.) Arup, Söchting & Frödén

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, stepe vegetation, 40° 08' 21.00" N, 25° 56' 42.77" E, 29 m, 28 November 2019, [MAR 0.023].

**Description:** Thallus is well developed, composed of yellow and orange colored areoles, areoles sometimes quite convex, algae layer sometimes forming tooth-shaped clusters under the upper cortex layer. Apothecia, brownish orange, (0.25–)0.34–0.58–0.82(–1.75) mm in diameter. Hymenium, (55–)69.39–84.17–98.94(–115) µm wide. Paraphyseal tips (2.5–)4.18–5.04–5.9(–7) µm. Ascospores (9–)10.48–11.59–12.69(–14.5) × (4.5–)5.75–6.63–7.51(–9) µm, septum (1–)2.44–3.3–4.16(–5.5) µm, ascospore length/width ratio (1.31–)1.55–1.77–1.99(–2.4), septa/length ratio (0–)0.2–0.28–0.36(–0.48).

**Substrate and ecology:** on calcereous rocks. The lichen sample (MAR 0.023) we collected is found on calcereous rocks.

**World distribution:** Europe.

**Notes:** It forms polyphyletic groups within the genus *Variospora*. In particular, specimens living in xerothermic habitats with extremely thick areoles and prominent algae clusters under the upper cortex constitute a different clade, and may be identified as a different species in the future as a result of more detailed studies with these groups. This species is distinguished from other species by having a well-developed areolate thallus and almost globose ascospores [58].



**Figure 4.59.** *Variospora dolomiticola*. Thallus and apothecia.

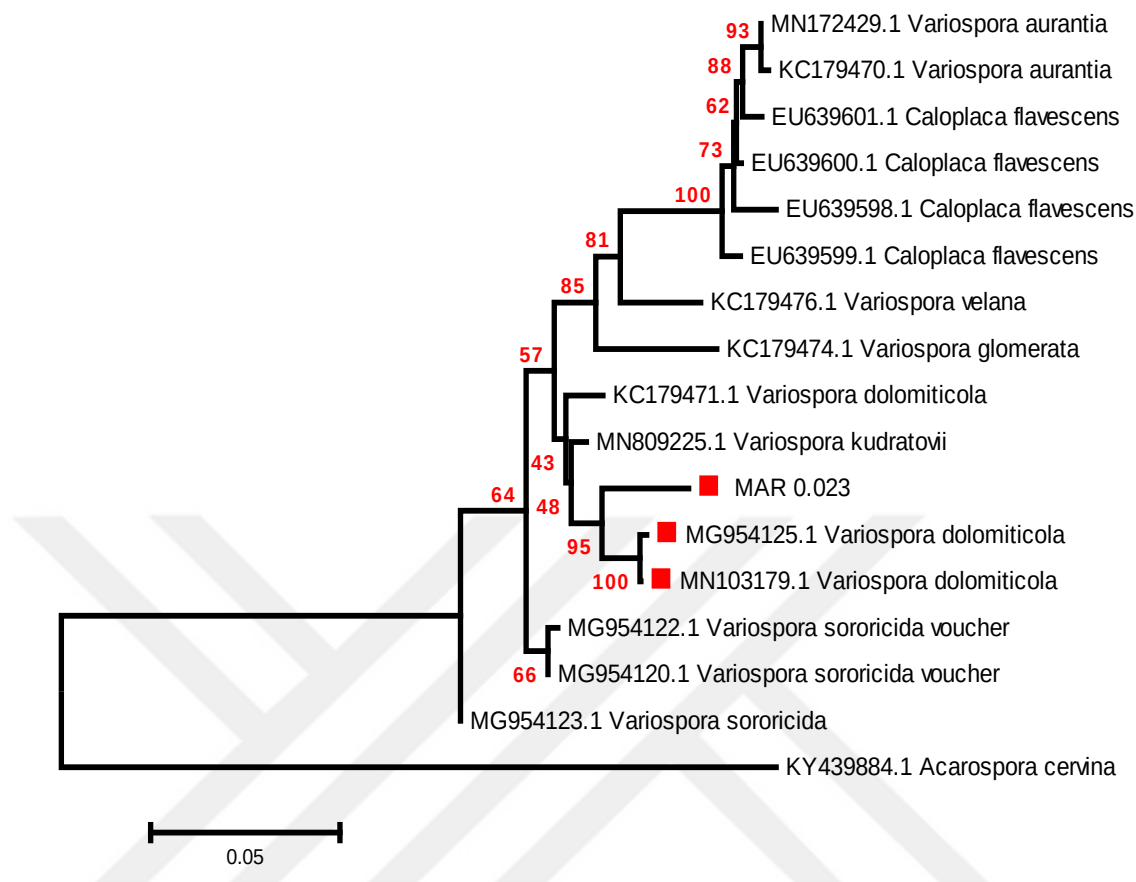


**Figure 4.60.** Neighbour-Joining dendrogram of *Variospora dolomiticola* and related species (MAR 0.023).

#### 4.1.37. *Variospora flavescens* (Huds.) Arup, Frödén & Søchting

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, stepe vegetation, 40° 08' 21.00" N, 25° 56' 42.77" E, 29 m, 28 November 2019, [MAR 0.026].

**Description:** Thallus marginally lobed, smooth, pale yellow to orange, 6.5–35 mm diam. The marginal lobes are convex throughout. The cortex is parapletenchymatic, there is a crystalline layer. The thallus can sometimes be covered with pustules in the centre. Apothecia brownish-orange, few, (0.4–)0.48–0.69–0.89(–1.3) mm in diameter. Hymenium (75–)80.87–91.67–102.47(–105)  $\mu\text{m}$  wide. Paraphyse tips (3.5–)4.05–5.1–6.15(–7)  $\mu\text{m}$ . Ascospores (9–)10.04–11.72–13.4(–14.5)  $\times$  (5–)6.42–7.7–8.98(–10)  $\mu\text{m}$ , septa (2–)2.4–3.4–4.4(–6)  $\mu\text{m}$ , ascospore length/width ratio (1.05–)1.28–1.55–1.81(–2.45), septa/length ratio (0.14–)0.22–0.29–0.37(–0.46).

**Substrate and ecology:** on calcereous rocks. The lichen sample (MAR 0.026) we collected is found on calcereous rocks.

**World distribution:** Europe.

**Notes:** *Variospora flavescens* (Huds.) Arup, Frödén & Söchting is clearly distinguished from all species in the group by the presence of a fixed crystal layer under the pigmented part of the cortex. However, in some cases it can be confused with *V. thallincola* (Wedd.) Arup, Frödén & Söchting or *V. aegaea* (Sipman) Arup, Frödén & Söchting macroscopically. In such cases, *V. flavescens* can be recognized by the presence of a thin layer of pruinose, particularly concentrated in the central parts of the thallus [67].



**Figure 4.61.** *Variospora flavescens*. Thallus and apothecia.

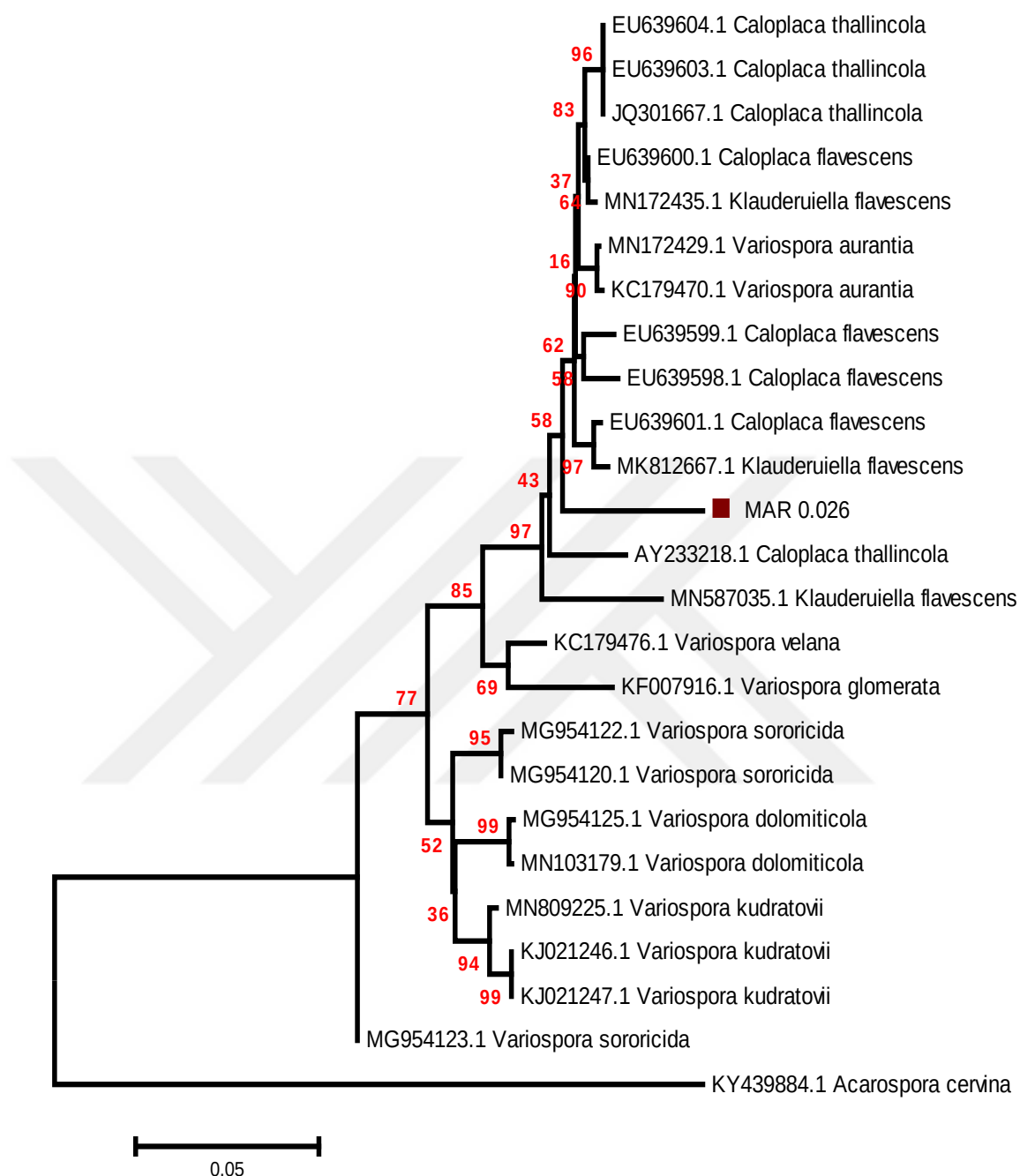


**Figure 4.62.** Neighbour-Joining dendrogram of *Variospora flavescent* and related species (MAR 0.026).

#### 4.1.38. *Verrucaria macrostoma* DC., in Lamarck & de Candolle

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, stepe vegetation, 40° 08' 21.00" N, 25° 56' 42.77" E, 29 m, 28 November 2019, [MAR 0.021].

**Description:** Thallus cracked-areolate, 0.3-0.6 mm thick, pale to dark brown, dull. Perithecia, fully immersed within areoles or with slightly emergent tips. Exciple,

broadly pyriform, colorless to dark brown, 0.3-0.4 mm wide. Asci, clavate, 85-105 x 25-30  $\mu\text{m}$ , 8-spored. Ascospores, hyaline, simple, ellipsoid, 20-28 x 10-13  $\mu\text{m}$ . Pycnidia, immersed, 50-100  $\mu\text{m}$  across. Spot tests, all negative.

**Substrate and ecology:** On calcereous rocks. The lichen sample (MAR 0.021) we collected is found on calcereous rocks.

**World distribution:** Europe, North Africa, and North America.

**Notes:** Similar specimens with deeper reaching involucrellum and larger spores refer to *Verrucaria murorum* (A. Massal.) Lindau. *Verrucaria viridula* (Schrad.) Ach. comes close in overall appearance but differs in larger, distinctly pear- to bottle-shaped perithecia, larger spores and longer periphyses [58].



**Figure 4.63.** General view of *Verrucaria macrostoma*.



**Figure 4.64.** Neighbour-Joining dendrogram of *Verrucaria macrostoma* and related species (MAR 0.021).

#### 4.1.39. *Xanthoria calcicola* (Oxner)

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, 200 m, 29 November 2019, [MAR 0.017].

**Description:** Thallus, foliose, to 8(-12) cm in diam. Lobes deep orange, 2-5 mm wide. Apothecia, often present, lecanorine, yellow to orange. Epithecium, orange-brown, K+ red. Hymenium colourless, c. 80 µm tall. Hypothecium, colourless. Asci, 8-spored, clavate. Ascospores, hyaline, polarilocular, ellipsoid, 10-15 x 7-9 µm, the septum 5-6.5 µm thick. Thallus and apothecia K+ dark red, C-, KC-, P-.

**Substrate and ecology:** On calcareous and basic siliceous. The lichen sample (MAR 0.017) we collected is found on calcareous rocks.

**World distribution:** Europe.

**Notes:** a mainly Mediterranean to mild-temperate lichen found on the top of isolated calcareous and basic siliceous boulders, and (limited to the western side of the Peninsula) abundant also on roofing tiles; in strongly eutrophicated situations it can occasionally overgrow bryophytes and plant remains, and, albeit very rarely, it has been also found on dust-impregnated bark [58].



**Figure 4.65.** *Xanthoria calcicola*. Thallus and apothecia.

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

**Specimen studied:** Turkey, Çanakkale, Gökçeada, Gökçeada-Eşelik highway, Kefalos beach, 40° 07' 43.14" N, 25° 56' 35.32" E, 200 m, 29 November 2019, [MAR 0.010].

**Description:** Thallus foliose, forming rosettes or irregular, weakly appressed to the substrate. Lobes slightly convex, rounded, rather thick. Upper surface olive-brown, yellowish-brown or slightly darker, distinctly, wrinkled, slightly shining at tips of the lobes, without isidia. Apothecia frequent. Secondary metabolites detected by TLC: stenosporic (+), divaricatic (+), perlatolic (t), oxostenosporic (t), 4-O demethylstenosporic (t), and gyrophoric (+) acids.

**Substrate and ecology:** On siliceous rocks. The lichen sample (MAR 0.010) we collected is found on siliceous rocks.

**World distribution:** It has a wide distribution area around the world.

**Notes:** *X. delisei* (Duby) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch were originally identified as *X. pulla* (Ach.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch. the taxa are morphologically almost identical, although in somecases they can be separated on the basis of morphologicalfeatures, such as the color of thalli (paler and yellowish togray-brown in *X. delisei*, darker brown in *X. pulla*) and theappearance and shape of the lobes (broader, thicker and morestrongly maculate in *X. pulla*) [58].



**Figure 4.66.** *Xanthoparmelia pulla* thallus.

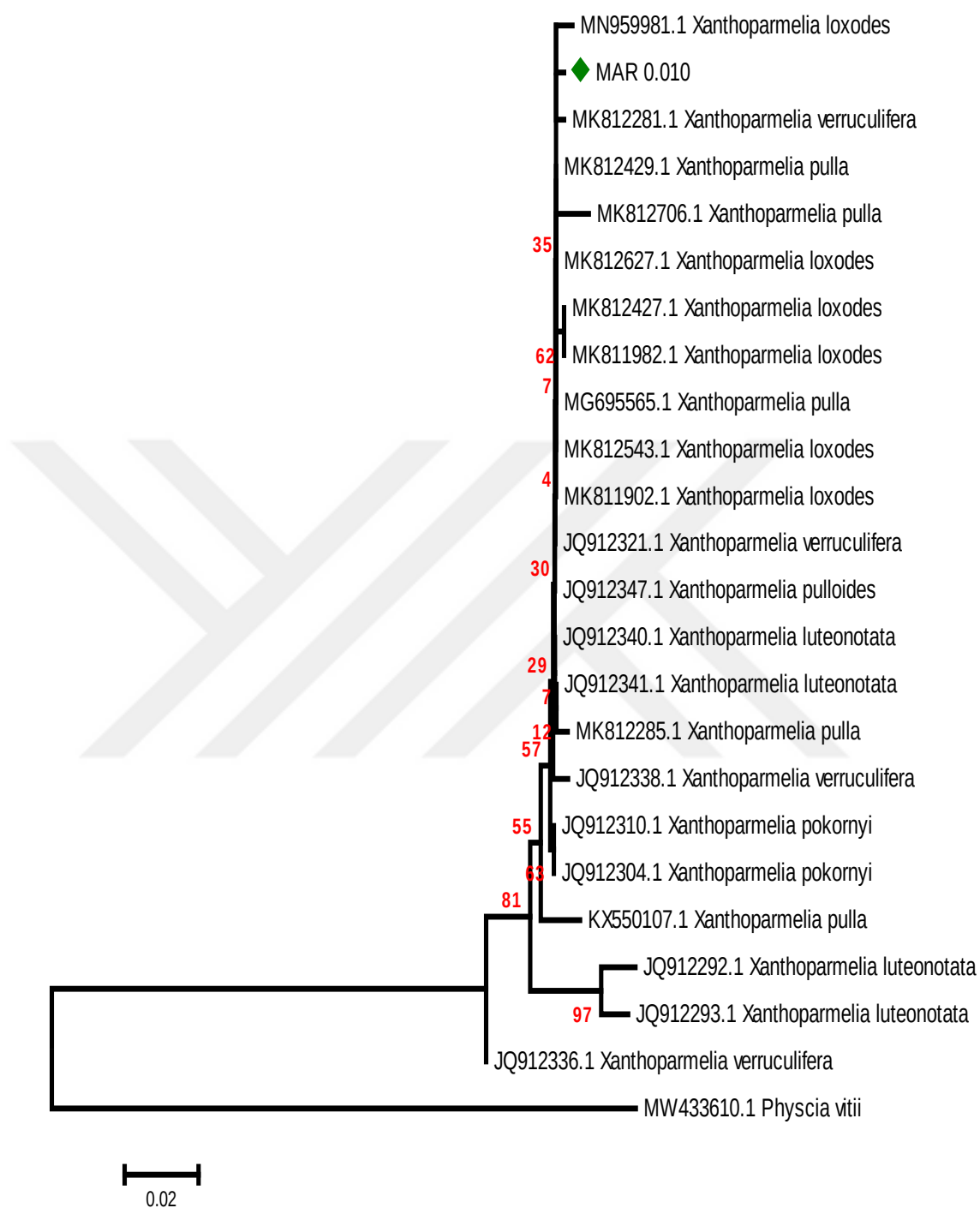


**Figure 4.67.** Neighbour-Joining dendrogram of *Xanthoparmelia pulla* and related species (MAR 0.010).

## CHAPTER 5

### DISCUSSION AND RECOMMENDATIONS

Biodiversity is one of the most basic conditions for determining the flora of a country. For this reason, it is aimed to examine the morphological and anatomical characters of Gökçeada (Çanakkale) lichens and to prepare their descriptions, to reproduce the rDNA (ITS) regions with the help of PCR and to examine the relevant regions by sequence analysis method, to evaluate the obtained results together with other data from the gene bank and to reveal the differences and similarities between the species. This study will make an important contribution to the biodiversity of Turkey.

In this study, 40 lichen taxa collected from Gökçeada were studied. Molecular results could not be obtained from all of these taxa whose morpho-anatomical studies were performed. Detailed descriptions of lichen samples, which have both molecular results and studied only morphologically-anatomically, are given.

Separate phylogenetic dendograms were created for each genus with the data obtained using the MEGA 7.0 program and the Neighbor Joining method. During the creation of these dendograms, some of the species associated with the studied samples from the Genbank were used. The species taken from the gene bank and the species we used in our study generally branched in harmony with each other.

Çobanoğlu and Sevgi (2006) carried out the study "Contribution to the lichen flora of Gürgen Mountain (Çanakkale)". In this work, A list of 75 lichen taxa is reported from Gürğendağı Mountain located to the north of Kazdağı (Ida Mountain), in Çanakkale province. Among the identified taxa, 41 taxa are epiphytic, 26 saxicolous and 8 terricolous. All of the taxa are new records for the area. Nineteen taxa are new for the province [68].

Oran (2021), carried out the study "Additions to the lichen biota of the Kaz Mountains (Çanakkale-Balıkesir, Turkey)". In this work, 195 lichen taxa and one lichenicolous

fungus are reported from the Kaz Mountains. *Rhizocarpon jemtlandicum* and *Rinodina moziana* are new to Turkey [69].

In the NJ dendogram made for the *Acarospora veronensis* lichen species, the sample with the number MAR 0.035 studied and the species in the genus *Acarospora* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *A. veronensis* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Candelariella aurella* lichen species was used as the outgroup.

In the NJ dendogram made for the *Aspiciliella intermutans* lichen species, the samples with the number MAR 0.009 and MAR 0.015 studied and the species in the genus *Aspiciliella* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *A. intermutans* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Xanthoria parietina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Blastenia crenularia* lichen species, the sample with the number MAR 0.037 studied and the species in the genus *Blastenia* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *B. crenularia* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Buellia subdisciformis* lichen species, the sample with the number MAR 0.041 studied and the species in the genus *Buellia* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *B. subdisciformis* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Candelariella aurella* lichen species, the samples with the number MAR 0.004 and MAR 0.024 studied and the species in the genus *Candelariella* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *C. aurella* species. In addition,

other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Circinaria mansourii* lichen species, the sample with the number MAR 0.032 studied and the species in the genus *Circinaria* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *C. mansourii* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Xanthoria parietina* lichen species was used as the outgroup. *Circinaria mansourii* is a new record for Turkey. This species was first reported by Barak et al. (2016) from Kayseri province in 2016 [70]. With this thesis, this species was recorded from Gökçeada (Çanakkale) for the second time.

In the NJ dendogram made for the *Diplotomma alboatrum* and *Diplotomma venustum* lichen species, the samples with the number MAR 0.027 and MAR 0.029 studied and the species in the genus *Diplotomma* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *D. alboatrum* and *D. venustum* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Lecanora campestris* lichen species, the sample with the number MAR 0.022 studied and the species in the genus *Lecanora* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *L. campestris* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Lecanora chlarotera* lichen species, the sample with the number MAR 0.007 studied and the species in the genus *Lecanora* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *L. chlarotera* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Lecidella flavosorediata* lichen species, the sample with the number MAR 0.043 studied and the species in the genus *Lecidella* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *L. flavosorediata* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup. This species was first identified by Volker John in 1988 from Aydın province [71]. With this thesis, this species was recorded from Gökçeada (Çanakkale) for the second time.

In the NJ dendogram made for the *Physcia adscendens* and *Physcia dubia* lichen species, the samples with the number MAR 0.014 and MAR 0.013 studied and the species in the genus *Physcia* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *P. adscendens* and *P. dubia* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Parmelia serrana* lichen species was used as the outgroup.

In the NJ dendogram made for the *Glaucomaria sulphurea* and *Polyozosia schofieldii* lichen species, the sample with the number MAR 0.040 and MAR 0.002 studied and the species in the genus *Polyozosia* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *P. schofieldii* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Rinodina mniaroeiza* lichen species was used as the outgroup. *Polyozosia schofieldii* is a new record for Turkey.

In the NJ dendogram made for the *Protoparmelia montagnei* lichen species, the samples with the number MAR 0.039 and MAR 0.042 studied and the species in the genus *Protoparmelia* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *P. montagnei* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Lecanora muralis* lichen species was used as the outgroup.

In the NJ dendogram made for the *Protoparmeliopsis muralis* lichen species, the sample with the number MAR 0.031 studied and the species in the genus *Protoparmeliopsis*

from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *P. muralis* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Physcia vitii* lichen species was used as the outgroup.

In the NJ dendogram made for the *Pyrenodesmia albolutescens* lichen species, the sample with the number MAR 0.020 studied and the species in the genus *Pyrenodesmia* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *P. albolutescens* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Ramalina breviscula* lichen species, the samples with the number MAR 0.033 and MAR 0.044 studied and the species in the genus *Ramalina* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *R. breviscula* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup. This species was first detected in Muğla (2003) and Kırklareli (2005) provinces [71]. With this thesis, this species has been recorded for the third time from Gökçeada (Çanakkale).

In the NJ dendogram made for the *Rhizocarpon atroflavescens* lichen species, the sample with the number MAR 0.011 studied and the species in the genus *Rhizocarpon* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *R. atroflavescens* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup. *Rhizocarpon atroflavescens* is a new record for Turkey.

In the NJ dendogram made for the *Rinodina gennarii* lichen species, the sample with the number MAR 0.019 studied and the species in the genus *Rinodina* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *R. gennarii* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Rinodina oleae* lichen species, the sample with the number MAR 0.030 studied and the species in the genus *Rinodina* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *R. oleae* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Rinodina roboris* lichen species, the sample with the number MAR 0.038 studied and the species in the genus *Rinodina* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *R. roboris* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Parmelia serrana* lichen species was used as the outgroup. This species was first detected in Adıyaman (1921) and Ordu (2010) provinces [71]. With this thesis, this species has been recorded for the third time from Gökçeada (Çanakkale).

In the NJ dendogram made for the *Tephromela atra* var. *calcareae* lichen species, the sample with the number MAR 0.003 studied and the species in the genus *Tephromela* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *T. var. calcarea* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Umbilicaria iberica* lichen species was used as the outgroup.

In the NJ dendogram made for the *Toninia talparum* lichen species, the sample with the number MAR 0.005 studied and the species in the genus *Toninia* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *T. talparum* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Ramalina ovalis* lichen species was used as the outgroup. *Toninia talparum* is a new record for Turkey.

In the NJ dendogram made for the *Variospora aegaea* lichen species, the sample with the number MAR 0.001 studied and the species in the genus *Variospora* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *V. aegaea* species. In addition, other lichen species

taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Variospora dolomiticola* lichen species, the sample with the number MAR 0.023 studied and the species in the genus *Variospora* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *V. dolomiticola* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Variospora flavescens* lichen species, the sample with the number MAR 0.026 studied and the species in the genus *Variospora* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *V. flavescens* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Acarospora cervina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Verrucaria macrostroma* lichen species, the sample with the number MAR 0.021 studied and the species in the genus *Verrucaria* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *V. macrostroma* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Xanthoria parietina* lichen species was used as the outgroup.

In the NJ dendogram made for the *Xanthoparmelia pulla* lichen species, the sample with the number MAR 0.010 studied and the species in the genus *Xanthoparmelia* from the Genbank showed branching consistent branching. The studied lichen sample showed co-branching by matching with *X. pulla* species. In addition, other lichen species taken from the genebank also showed harmonious branching among themselves. *Physcia vitii* lichen species was used as the outgroup.

Lichens occupy a very important place in biodiversity. Lichens are one of the most important sources of biodiversity with their rich species diversity. For this reason, biodiversity studies on lichens are extremely important. Most of the biodiversity studies conducted in Turkey are carried out with examination at the morphological and anatomical level. Although morphological and anatomical characters are used as the

basis for systematic classification, they are highly likely to be changed by some factors such as environmental factors. For this reason, it is inevitable to use molecular-level studies as well as morpho-anatomical characters in order to obtain more precise and more accurate results.

In this study, rDNA ITS regions were amplified by PCR using primers ITS1F and ITS4. The DNA sequences of the amplified products were determined using the sequence analysis method. Then, the degree of evolutionary affinity and affinity between the species whose sequences were determined and the other species taken from the gene bank were examined and their places in the systematic step were determined more precisely. As a result, it was concluded that the rDNA ITS gene regions, which provide sufficient data to determine the systematic categories of organisms at the species level, to determine their interconnections and to determine evolutionary relationships, are suitable for this type of studies.

Conducting molecular systematic studies is of great importance in terms of biodiversity of Turkey. As the number of these and similar studies increases, the lichen biodiversity of Turkey will be determined more accurately and precisely.

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