



Diversity and distribution of arid-semi arid truffle (*Terfezia* and *Picoa*) in Elazığ-Malatya region of Turkey

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Akyüz M, Kırbağ S, Bircan B, Gürhan Y 2015 – Diversity and distribution of arid-semi arid truffle (*Terfezia* and *Picoa*) in Elazığ-Malatya region of Turkey. Mycosphere 6(6), 766–783, Doi 10.5943/mycosphere/6/6/11

Abstract

This work aims to conduct research for finding arid-semi arid (desert) truffles that grow in the Elazığ-Malatya area. It was determined that *Picoa lefebvrei*, *P. juniperi*, *Terfezia olbiensis*, *T. claveryi* and *T. boudieri* grew naturally in the study areas. Short descriptions of the taxon are provided together with the photographs of fruit bodies and macro-microstructures. In addition, we present new localities for *Picoa lefebvrei*, *P. juniperi*, *Terfezia olbiensis*, *T. claveryi* and *T. boudieri* in Turkey. The habitats of these species should be protected by turning the growing fields into natural protected areas.

Key words – Ascomycotina – arid-semi arid truffle – biodiversity – *Helianthemum* spp. – hypogeous – *Picoa* – *Terfezia*

Introduction

Turkey has one of the richest macrofungi floras in the northern hemisphere as it is located at the convergence of three phytogeographical regions: Euro-Siberian, Mediterranean, and Irano-Turanian. It has a potentially rich diversity of truffle taxa due to its unique phytogeographical location, climate and soil variability, and vegetation diversity (Castellano & Türkoğlu 2012, Türkoğlu et al. 2015). Truffles are edible hypogeous fruit bodies produced by many genera of fungi belonging to the class Ascomycetes G. Winter. The hypogeous ascocarps of these fungi are known as truffles. They can be classified as forest truffles, desert truffles, and semi-arid truffles. Among these, *Terfezia* (Tul. & C. Tul.) Tul. & C. Tul. (Pezizaceae Dumort.), *Tirmania* Chatin (Pezizaceae Dumort.), *Picoa* Vittad. (Pyrenomataceae Corda) and *Tuber* P. Micheli ex. F.H Wigg (Tuberaceae Dumort.) are classified in different taxa in Pezizales J. Schrot (Roth-Bejerano et al. 2004, Moreno et al. 2014). Underground members of the Pezizaceae are well distributed around the globe. Arid and semi arid truffles are adapted to exploit different types of soil in association with specific hosts (Diez et al. 2002). *Terfezia*, *Tirmania* and *Picoa* species form mycorrhizae mainly on roots of the family Cistaceae, including different species of the genus *Helianthemum* (L.) Miller (Mandeel & Al-Laith 2007, Kagan-Zur & Roth-Bejerano 2008, Kovacs et al. 2011, Chevalier 2014), as well as other symbionts.

Every country has the responsibility to determine its biological richnesses, protect their habitats, and ensure the continuation of the species. Although Turkey is rich in terms of mushroom type diversity, the country cannot make use of these adequately, and in fact, many species are at the

verge of extinction and under danger.

Little is known about the truffle diversity in Turkey (Türkoğlu & Castellano 2014), as truffle fungi have received less attention than epigeal fungi. To date, only ~ 60 truffle species have been reported from Turkey (Oder 1988, Işıloğlu & Oder 1995, Afyon 1996, Doğan & Ozturk 2006, Solak et al. 2007, Kaya 2009, Castellano & Türkoğlu 2012, Kagan-Zur & Akyuz 2014, Türkoğlu & Castellano 2014, Türkoğlu et al. 2015 etc.).

In the present study, *Picoa lefebvrei*, *P. juniperi*, *Terfezia olbiensis*, *T. claveryi* and *T. boudieri* are identified and added to the knowledge of the truffle flora of Turkey. And also, short descriptions of the taxon are provided together with the photographs of fruit bodies and macro-microstructures. In addition, we present new localities for the previously reported *Picoa lefebvrei*, *P. juniperi*, *Terfezia olbiensis*, *T. claveryi* and *T. boudieri*.

Materials & Methods

Wild samples of fresh *Picoa lefebvrei* (Pat.) Maire, *Picoa juniperi* Vittad., *Terfezia boudieri* Chatin, *Terfezia claveryi* Chatin and *Terfezia olbiensis* Tul. & C. Tul. were collected from Malatya (Central, Kale, Battalgazi, Arguvan Districts and their vicinity) and Elazığ (Baskil district and its vicinity), Turkey (N 38° 19' - 43' E 038° 19' - 51' with an altitude of 690-1375 m, the beginning of March to the end of May (rarely continue until mid-July), as shown in Fig. 1 and Table 1. They are found on mountain slopes, hilly areas, coastline, roadside, flat areas, steppe, arid-semi arid areas, grow under sandy soil, and appear with spring rains. They are usually collected near *Helianthemum salicifolium* (L.) Mill. and rarely *H. ledifolium* (L.) Mill. We identified the location of the truffles from crevices that appeared in the surface of the soil above the truffle. Micromorphological characters were recorded after rehydrating in 3% KOH or in distilled water (Alsheikh 1994, Montecchi & Sarasini 2000). Macromorphological characteristics, spores and sterile tissues were photographed with a compound microscope (Olympus SZ61 and CX41). Following standard mycological techniques, necessary macroscopic and microscopic data were obtained. The specimen was identified by examining their macroscopic and microscopic features, using references by Alsheikh & Trappe (1983), Gücin (1983), Alsheikh (1994), Moreno et al. (2000), Montecchi & Sarasini (2000), Kirk et al. (2008), Gücin et al. (2010), Castellano & Türkoğlu (2012), Türkoğlu & Castellano (2014), Türkoğlu et al. (2015), and Kagan-Zur et al. (2014). The samples were cleaned, cut into slices, dried at room temperature, and then stored.

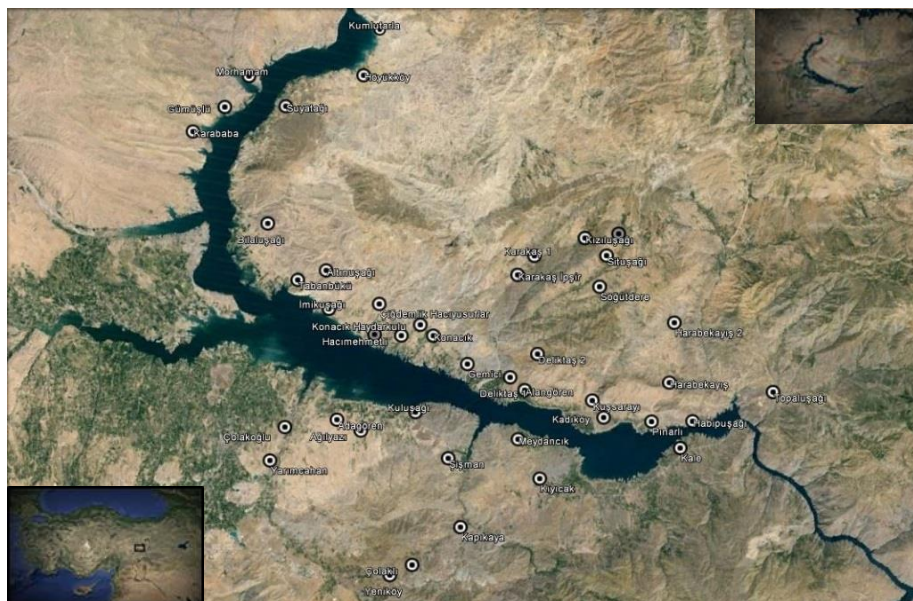


Fig. 1 – Map of the study area (where Malatya (Centre, Kale, Battalgazi, Arguvan districts and their vicinities) and Elazığ (Baskil district and its vicinity) provincial borders intersect, together with the area around Kömürhan Bridge, and at areas along the shores of the Karakaya Dam).

Table 1 The locations, GPS coordinates, host plant and the location altitudes of the arid and semi-arid truffle types that grow in the Elazığ-Malatya area of Turkey.

Truffle types	Host plant	Locality	GPS Coordinates	Altitude (m)
<i>T. boudieri</i>	<i>H. salicifolium</i>	Kale and its vicinity,	N 38°25' E038°46'	698-762
<i>P. lefebvrei</i>		Kale - Malatya	N 38°25' E038°45'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Kıyıcak village and its vicinity,	N 38°23' E038°37'	729-886
<i>T.olbiensis</i>		Kale - Malatya	N 38°23' E038°38'	
<i>P. lefebvrei</i>			N 38°23' E038°39'	
			N 38°24' E038°38'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Kapıkaya village and its vicinity,	N 38°21' E038°33'	756-927
<i>P. lefebvrei</i>		Centre - Malatya	N 38°21' E038°34'	
			N 38°21' E038°35'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Çolaklı village and its vicinity,	N 38°20' E038°31'	913-1089
<i>P. lefebvrei</i>		Centre - Malatya	N 38°20' E038°32'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Yeniköy village and its vicinity,	N 38°19' E038°31'	1006-1096
<i>P. lefebvrei</i>		Centre - Malatya	N 38°19' E038°30'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Meydancık village and its vicinity,	N 38°25' E038°37'	782-895
<i>T.olbiensis</i>		Battalgazi - Malatya	N 38°25' E038°38'	
<i>P. lefebvrei</i>			N 38°24' E038°38'	
<i>P. juniperi</i>				
<i>T. boudieri</i>	<i>H. salicifolium</i>	Yarımcahan village and its vicinity,	N 38°24' E038°23'	753-889
<i>T.olbiensis</i>		vicinity, Battalgazi - Malatya	N 38°24' E038°24'	
<i>P. lefebvrei</i>			N 38°24' E038°25'	
			N 38°24' E038°26'	
			N 38°25' E038°24'	
			N 38°25' E038°26'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Çolakoğlu village and its vicinity,	N 38°26' E038°25'	715-782
<i>T.olbiensis</i>		Battalgazi - Malatya	N 38°25' E038°25'	
<i>P. lefebvrei</i>			N 38°25' E038°24'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Adagören village and its vicinity,	N 38°26' E038°27'	706-763
<i>T.olbiensis</i>		Battalgazi - Malatya	N 38°26' E038°28'	
<i>P. lefebvrei</i>				
<i>T. boudieri</i>	<i>H. salicifolium</i>	Ağılyazı village and its vicinity,	N 38°26' E038°29'	728-808
<i>T.olbiensis</i>		Battalgazi - Malatya	N 38°25' E038°28'	
<i>P. lefebvrei</i>			N 38°25' E038°29'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Kuluşağı village and its vicinity,	N 38°26' E038°30'	703-764
<i>T.olbiensis</i>		Battalgazi - Malatya	N 38°26' E038°31'	
<i>P. lefebvrei</i>			N 38°26' E038°32'	
			N 38°26' E038°33'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Şişman village and its vicinity,	N 38°24' E038°34'	748-881
<i>T.olbiensis</i>		Battalgazi - Malatya	N 38°24' E038°33'	
<i>P. lefebvrei</i>			N 38°24' E038°32'	
			N 38°24' E038°31'	
			N 38°25' E038°33'	
			N 38°25' E038°31'	
			N 38°25' E038°30'	
			N 38°25' E038°29'	
			N 38°25' E038°28'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Gümüşlü village and its vicinity,	N 38°39' E038°22'	705-762
<i>P. lefebvrei</i>		Arguvan - Malatya	N 38°39' E038°21'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Morhamam village and its vicinity,	N 38°41' E038°22'	712-754
<i>P. lefebvrei</i>		Arguvan - Malatya	N 38°40' E038°23'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Karababa village and its vicinity,	N 38°38' E038°20'	719-746
<i>P. lefebvrei</i>		Arguvan - Malatya	N 38°38' E038°19'	
<i>T. boudieri</i>	<i>H. salicifolium</i>	Topaluşağı village and its vicinity,	N 38°28' E038°50'	691-884
<i>P. lefebvrei</i>		Elazığ - Malatya provincial borders, Baskil -Elazığ	N 38°27' E038°50'	
			N 38°27' E038°51'	
			N 38°27' E038°49'	
			N 38°27' E038°48'	
			N 38°26' E038°49'	

Truffle types	Host plant	Locality	GPS Coordinates	Altitude (m)
<i>T. boudieri</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Habipuşağı village and its vicinity, Baskil - Elazığ	N 38°27' E038°47' N 38°26' E038°47' N 38°26' E038°46' N 38°26' E038°45'	696-768
<i>T. boudieri</i> <i>T. olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Pınarlı village and its vicinity, Baskil - Elazığ	N 38°26' E038°45' N 38°26' E038°44' N 38°26' E038°43'	699-771
<i>T. boudieri</i> <i>T. olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Kadıköy village and its vicinity, Baskil - Elazığ	N 38°26' E038°42' N 38°26' E038°41' N 38°25' E038°41'	704-806
<i>T. boudieri</i> <i>T. olbiensis</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Kuşsarayı village and its vicinity, Baskil - Elazığ	N 38°27' E038°41' N 38°27' E038°40' N 38°27' E038°39'	777-834
<i>T. boudieri</i> <i>T. olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Alangören village and its vicinity, Baskil - Elazığ	N 38°27' E038°38' N 38°27' E038°37' N 38°28' E038°37'	736-790
<i>T. boudieri</i> <i>T. olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i> <i>H. ledifolium</i>	Deliktaş village and its vicinity, Baskil - Elazığ	N 38°27' E038°37' N 38°28' E038°37' N 38°28' E038°36' N 38°29' E038°37' N 38°29' E038°38' N 38°29' E038°39'	762-1353
<i>T. boudieri</i> <i>T. claveryi</i> <i>T. olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Gemici village and its vicinity, Baskil - Elazığ	N 38°28' E038°35' N 38°28' E038°34' N 38°29' E038°35' N 38°29' E038°34' N 38°29' E038°33'	759-818
<i>T. boudieri</i> <i>T. olbiensis</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Konacık village, Haydarkulu hamlet and its vicinity, Baskil - Elazığ	N 38°31' E038°33' N 38°31' E038°34' N 38°30' E038°33' N 38°30' E038°32' N 38°30' E038°31' N 38°29' E038°33'	762-922
<i>T. boudieri</i> <i>T. claveryi</i> <i>T. olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Hacımehmetli village and its vicinity, Baskil - Elazığ	N 38°30' E038°32' N 38°30' E038°31' N 38°29' E038°31' N 38°29' E038°32'	728-790
<i>T. boudieri</i> <i>T. claveryi</i> <i>T. olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Çiğdemlik village, Hacıyusuflar hamlet and its vicinity, Baskil - Elazığ	N 38°29' E038°30' N 38°30' E038°30' N 38°30' E038°29' N 38°29' E038°29' N 38°31' E038°30' N 38°31' E038°29' N 38°30' E038°28' N 38°31' E038°28'	701-837
<i>T. boudieri</i> <i>T. olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i> <i>H. ledifolium</i>	Karakaş village, İpşir hamlet and its vicinity, Baskil - Elazığ	N 38°32' E038°36' N 38°32' E038°37'	1115-1260
<i>T. boudieri</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Kızıluşağı village and its vicinity, Baskil - Elazığ	N 38°34' E038°40' N 38°34' E038°41'	1303-1356
<i>T. boudieri</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Yalındam village and its vicinity, Baskil - Elazığ	N 38°34' E038°42'	1320-1375
<i>T. boudieri</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Situşağı village and its vicinity, Baskil - Elazığ	N 38°33' E038°42' N 38°33' E038°41'	1251-1351

Truffle types	Host plant	Locality	GPS Coordinates	Altitude (m)
<i>T. boudieri</i> <i>T.olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Söğütdere village and its vicinity, Baskil - Elazığ	N 38°32' E038°41' N 38°31' E038°41'	1174-1210
<i>T. boudieri</i> <i>T.olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Harabekayış village and its vicinity Baskil - Elazığ	N 38°28' E038°45' N 38°28' E038°44' N 38°27' E038°45' N 38°27' E038°44' N 38°29' E038°45' N 38°30' E038°44' N 38°30' E038°45'	900-1200
<i>T. boudieri</i> <i>T.olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	İmikuşağı village and its vicinity, Baskil - Elazığ	N 38°31' E038°27' N 38°30' E038°28'	724-812
<i>T. boudieri</i> <i>T.olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Tabanbükü village and its vicinity Baskil - Elazığ	N 38°31' E038°25' N 38°32' E038°25' N 38°33' E038°25'	730-812
<i>T. boudieri</i> <i>T.olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Altınuşağı Village and its vicinity, Baskil - Elazığ	N 38°32' E038°27' N 38°32' E038°26'	800-950
<i>T. boudieri</i> <i>T. claveryi</i> <i>T.olbiensis</i> <i>P. lefebvrei</i> <i>P. juniperi</i>	<i>H. salicifolium</i>	Bilaluşağı village and its vicinity, Baskil - Elazığ	N 38°34' E038°24' N 38°33' E038°24' N 38°34' E038°23' N 38°35' E038°23' N 38°36' E038°23' N 38°36' E038°22' N 38°37' E038°22' N 38°37' E038°23'	722-893
<i>T. boudieri</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Suyatağı village and its vicinity, Baskil - Elazığ	N 38°39' E038°24' N 38°40' E038°25' N 38°40' E038°24' N 38°39' E038°25' N 38°38' E038°23' N 38°37' E038°23'	690-815
<i>T. boudieri</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Höyükköy village and its vicinity, Baskil - Elazığ	N 38°41' E038°29' N 38°40' E038°29' N 38°40' E038°28'	709-740
<i>T. boudieri</i> <i>P. lefebvrei</i>	<i>H. salicifolium</i>	Kumlutarla village and its vicinity, Baskil - Elazığ	N 38°42' E038°30' N 38°43' E038°29'	702-750

Results

Kingdom: Myceteae

Classis: Ascomycetes

Pyronemataceae Corda.

Picoa Vittad.

***Picoa lefebvrei* (Pat.) Maire**

Malatya city Central district (are found in the areas surrounding Kapıkaya village and its vicinity N 38°21' E038°33', N 38°21' E038°34', N 38°21' E038°35', 756-927 m, Çolaklı village and its vicinity N 38°20' E038°31', N 38°20' E038°32', 913-1089 m, Yeniköy village and its vicinity N 38°19' E038°31', N 38°19' E038°30', 1006-1096 m), **Kale district** (are found in the areas surrounding Kale center and its vicinity N 38°25' E038°46', N 38°25' E038°45', 698-762 m, Kıyıcak village and its vicinity N 38°23' E038°37', N 38°23' E038°38', N 38°23' E038°39', N 38°24' E038°38', 729-886 m), **Battalgazi district** (are found in the areas surrounding Meydancık village and its vicinity N 38°25' E038°37', N 38°25' E038°38', N 38°24' E038°38', 782-895 m,

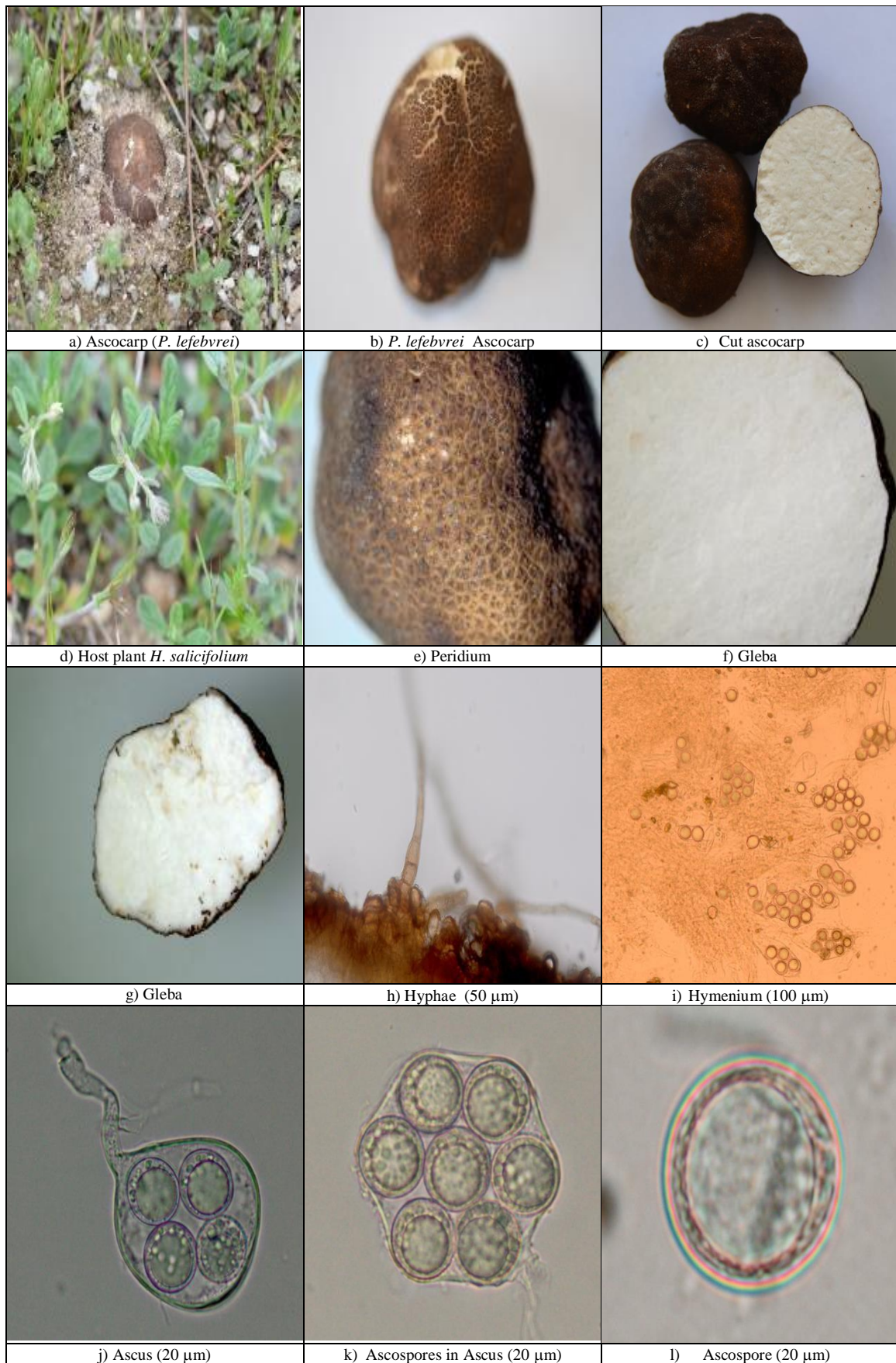


Fig. 2 – The macroscopic and microscopic characteristics (ascocarp, host plant, peridium, gleba, hyphae, hymenium, ascus and ascospore) of *P. lefebvrei* that were found in the Elazığ – Malatya area.

Yarımcahan village and its vicinity N 38°24' E038°23', N 38°24' E038°24', N 38°24' E038°25', N 38°24' E038°26', N 38°25' E038°24', N 38°25' E038°26', 753-889 m, Çolakoğlu village and its vicinity N 38°26' E038°25', N 38°25' E038°25', N 38°25' E038°24', 715-782 m, Adagören village and its vicinity N 38°26' E038°27', N 38°26' E038°28', 706-763 m, Ağilyazı village and its vicinity N 38°26' E038°29', N 38°25' E038°28', N 38°25' E038°29', 728-808 m, Kuluşağı village and its vicinity N 38°26' E038°30', N 38°26' E038°31', N 38°26' E038°32', N 38°26' E038°33', 703-764 m and Şişman village and its vicinity N 38°24' E038°34', N 38°24' E038°33', N 38°24' E038°32', N 38°24' E038°31', N 38°25' E038°33', N 38°25' E038°31', N 38°25' E038°30', N 38°25' E038°29', N 38°25' E038°28', 748-881 m) and **Arguvan district** (are found in the areas surrounding Gümüşlü village and its vicinity N 38°39' E038°22', N 38°39' E038°21', 705-762 m, Morhamam village and its vicinity N 38°41' E038°22', N 38°40' E038°23', 712-754 m and Karababa village and its vicinity N 38°38' E038°20', N 38°38' E038°19', 719-746 m). It was determined that *H. salicifolium*, which is its mycorrhiza, grows naturally from March to May (Table 1, Fig. 2). **Elazığ city Baskil district** (are found in the areas surrounding Topaluşağı village and its vicinity N 38°28' E038°50', N 38°27' E038°50', N 38°27' E038°51', N 38°27' E038°49', N 38°27' E038°48', N 38°26' E038°49', 691-884 m, Habipuşağı village and its vicinity N 38°27' E038°47', N 38°26' E038°47', N 38°26' E038°46', N 38°26' E038°45', 696-768 m, Pınarlı village and its vicinity N 38°26' E038°45', N 38°26' E038°44', N 38°26' E038°43', 699-771 m, Kadıköy village and its vicinity N 38°26' E038°42', N 38°26' E038°41', N 38°25' E038°41', 704-806 m, Kuşsarayı village and its vicinity N 38°27' E038°41', N 38°27' E038°40', N 38°27' E038°39', 777-834 m, Alangören village and its vicinity N 38°27' E038°38', N 38°27' E038°37', N 38°28' E038°37', 736-790 m, Deliktaş village and its vicinity N 38°27' E038°37', N 38°28' E038°37', N 38°28' E038°36' N 38°29' E038°37', N 38°29' E038°38', N 38°29' E038°39', 762-1353 m, Gemici village and its vicinity N 38°28' E038°35', N 38°28' E038°34', N 38°29' E038°35', N 38°29' E038°34', N 38°29' E038°33', 759-818 m, Konacık village, Haydarkulu hamlet and its vicinity N 38°31' E038°33', N 38°31' E038°34', N 38°30' E038°33', N 38°30' E038°32', N 38°30' E038°31', N 38°29' E038°33', 762-922 m, Hacımehmetli village and its vicinity N 38°30' E038°32', N 38°30' E038°31', N 38°29' E038°31', N 38°29' E038°32', 728-790 m, Çiğdemlik village, Hacıyusuflar hamlet and its vicinity N 38°29' E038°30', N 38°30' E038°30', N 38°30' E038°29', N 38°29' E038°29', N 38°31' E038°30', N 38°31' E038°29', N 38°30' E038°28', N 38°31' E038°28', 701-837 m, Karakaş village, İpşir hamlet and its vicinity N 38°32' E038°36', N 38°32' E038°37', 1115-1260 m, Kızıluşağı village and its vicinity N 38°34' E038°40', N 38°34' E038°41' 1303-1356 m, Yalındam village and its vicinity N 38°34' E038°42', 1320-1375 m, Şituşağı village and its vicinity N 38°33' E038°42', N 38°33' E038°41', 1251-1351 m, Söğütdere village and its vicinity N 38°31' E038°41', N 38°32' E038°41', 1174-1210 m, Harabekayış village and its vicinity N 38°28' E038°45', N 38°28' E038°44', N 38°27' E038°45', N 38°27' E038°44', N 38°29' E038°45', N 38°30' E038°44', N 38°30' E038°45', 900-1200 m, İmikuşağı village and its vicinity N 38°31' E038°27', N 38°30' E038°28', 724-812 m, Tabanbükü village and its vicinity N 38°31' E038°25', N 38°32' E038°25', N 38°33' E038°25', 730-812 m, Altınuşağı village and its vicinity N 38°32' E038°27', N 38°32' E038°26', 800-950 m, Bilaluşağı village and its vicinity N 38°34' E038°24', N 38°33' E038°24', N 38°34' E038°23', N 38°35' E038°23', N 38°36' E038°23', N 38°36' E038°22', N 38°37' E038°22', N 38°37' E038°23', 722-893 m, Suyatağı village and its vicinity N 38°39' E038°24', N 38°40' E038°25', N 38°40' E038°24', N 38°39' E038°25', N 38°38' E038°23', N 38°37' E038°23', 690-815 m, Höyükköy village and its vicinity N 38°41' E038°29', N 38°40' E038°29', N 38°40' E038°28', 709-740 m, Kumlutarla village and its vicinity N 38°42' E038°30', N 38°43' E038°29', 702-750 m). It was determined that *H. salicifolium*, which is its mycorrhiza, grows naturally from March to May (Table 1, Fig. 2).

P. lefebvrei samples that were collected in the Elazığ - Malatya area were analysed in detail, both macroscopically and microscopically (ascocarp, peridium, gleba, host plant, hymenium, hyphae, ascus and ascospore), and the results are presented in Fig. 2.

***Picoa juniperi* Vittad.**

Malatya city Battalgazi district (are found in the areas surrounding Meydancık village and its vicinity N 38°25' E038°37', N 38°25' E038°38', N 38°24' E038°38', 782-895 m) seen in Table 1.

Elazığ city Baskil district (are found in the areas surrounding Pınarlı village and its vicinity N 38°26' E038°45', N 38°26' E038°44', N 38°26' E038°43', 699-771 m, Kadıköy village and its vicinity N 38°26' E038°42', N 38°26' E038°41', N 38°25' E038°41', 704-806 m, Alangören village and its vicinity N 38°27' E038°38', N 38°27' E038°37', N 38°28' E038°37', 736-790 m, Deliktaş village and its vicinity N 38°27' E038°37', N 38°28' E038°37', N 38°28' E038°36', N 38°29' E038°37', N 38°29' E038°38', N 38°29' E038°39', 762-1353 m, Gemici village and its vicinity N 38°28' E038°35', N 38°28' E038°34', N 38°29' E038°35', N 38°29' E038°34', N 38°29' E038°33', 759-818 m, Hacımehmetli village and its vicinity N 38°30' E038°32', N 38°30' E038°31', N 38°29' E038°31', N 38°29' E038°32', 728-790 m, Çiğdemlik village, Hacıyusuflar hamlet and its vicinity N 38°29' E038°30', N 38°30' E038°30', N 38°30' E038°29', N 38°29' E038°29', N 38°31' E038°30', N 38°31' E038°29', N 38°30' E038°28', N 38°31' E038°28', 701-837 m, Karakaş village, İpşir hamlet and its vicinity N 38°32' E038°36', N 38°32' E038°37', 1115-1260 m, Söğütdere village and its vicinity N 38°31' E038°41', N 38°32' E038°41', 1174-1210 m, Harabekayış village and its vicinity N 38°28' E038°45', N 38°28' E038°44', N 38°27' E038°45', N 38°27' E038°44', N 38°29' E038°45', N 38°30' E038°44', N 38°30' E038°45', 900-1200 m, İmikuşağı village and its vicinity N 38°31' E038°27', N 38°30' E038°28', 724-812 m, Tabanbükü village and its vicinity N 38°31' E038°25', N 38°32' E038°25', N 38°33' E038°25', 730-812 m, Altınuşağı village and its vicinity N 38°32' E038°27', N 38°32' E038°26', 800-950 m, Bilaluşağı village and its vicinity N 38°34' E038°24', N 38°33' E038°24', N 38°34' E038°23', N 38°35' E038°23', N 38°36' E038°23', N 38°36' E038°22', N 38°37' E038°22', N 38°37' E038°23', 722-893 m).

P. juniperi samples that were collected in the Elazığ - Malatya area were analysed in detail, both macroscopically and microscopically (ascocarp, peridium, gleba, host plants, ascus and ascospore), and the results are presented in Fig. 3.

Pezizaceae Dumort.

***Terfezia* (Tul. & C.Tul) Tul. & C.Tul.**

***Terfezia boudieri* Chatin**

Malatya city Central district (are found in the areas surrounding Kapıkaya village and its vicinity N 38°21' E038°33', N 38°21' E038°34', N 38°21' E038°35', 756-927 m), Çolaklı village and its vicinity N 38°20' E038°31', N 38°20' E038°32', 913-1089 m, Yeniköy village and its vicinity N 38°19' E038°31', N 38°19' E038°30', 1006-1096 m), **Kale district** (are found in the areas surrounding Kale centre and its vicinity N 38°25' E038°46', N 38°25' E038°45', 698-762 m, Kıyıcak village and its vicinity N 38°23' E038°37', N 38°23' E038°38', N 38°23' E038°39', N 38°24' E038°38', 729-886 m), **Battalgazi district** (are found in the areas surrounding Meydancık village and its vicinity N 38°25' E038°37', N 38°25' E038°38', N 38°24' E038°38', 782-895 m, Yarımcahan village and its vicinity N 38°24' E038°23', N 38°24' E038°24', N 38°24' E038°25', N 38°24' E038°26', N 38°25' E038°24', N 38°25' E038°26', 753-889 m, Çolakoğlu village and its vicinity N 38°26' E038°25', N 38°25' E038°25', N 38°25' E038°24', 715-782 m, Adagören village and its vicinity N 38°26' E038°27', N 38°26' E038°28', 706-763 m, Ağilyazı village and its vicinity N 38°26' E038°29', N 38°25' E038°28', N 38°25' E038°29', 728-808 m, Kuluşağı village and its vicinity N 38°26' E038°30', N 38°26' E038°31', N 38°26' E038°32', N 38°26' E038°33', 703-764 m and Şişman village and its vicinity N 38°24' E038°34', N 38°24' E038°33', N 38°24' E038°32', N 38°24' E038°31', N 38°25' E038°33', N 38°25' E038°31', N 38°25' E038°30', N 38°25' E038°29', N 38°25' E038°28', 748-881 m) and **Arguvan district** (are found in the areas surrounding Gümüşlü village and its vicinity N 38°39' E038°22', N 38°39' E038°21', 705-762 m, Morhamam village and its vicinity N 38°41' E038°22', N 38°40' E038°23', 712-754 m, Karababa village and its vicinity N 38°38' E038°20', N 38°38' E038°19', 719-746 m). It was determined that *H. salicifolium*, which is its mycorrhiza, grows naturally from March to May (rarely continue until mid-July) (Table 1, Fig. 4).



Fig. 3 – The macroscopic and microscopic characteristics (ascocarp, host plant, peridium, gleba, ascus and ascospores) of *P. juniperi* that were found in the Elazığ - Malatya area.

It was determined that mostly *H. salicifolium* and rarely *H. ledifolium* which are its mycorrhiza, grows naturally from March to May (Table 1, Fig. 3).

Elazığ city Baskil district (are found in the areas surrounding Topaluşağı village and its vicinity N 38°28' E038°50', N 38°27' E038°50', N 38°27' E038°51', N 38°27' E038°49', N 38°27' E038°48', N 38°26' E038°49', 691-884 m, Habipuşağı village and its vicinity N 38°27' E038°47', N 38°26' E038°47', N 38°26' E038°46', N 38°26' E038°45', 696-768 m, Pınarlı village and its vicinity N 38°26' E038°45', N 38°26' E038°44', N 38°26' E038°43', 699-771 m, Kadıköy village and its vicinity N 38°26' E038°42', N 38°26' E038°41', N 38°25' E038°41', 704-806 m, Kuşsarayı village and its vicinity N 38°27' E038°41', N 38°27' E038°40', N 38°27' E038°39', 777-834 m, Alangören village and its vicinity N 38°27' E038°38', N 38°27' E038°37', N 38°28' E038°37', 736-790 m, Deliktaş village and its vicinity N 38°27' E038°37', N 38°28' E038°37', N 38°28' E038°36', N 38°29' E038°37', N 38°29' E038°38', N 38°29' E038°39', 762-1353 m, Gemici village and its vicinity N 38°28' E038°35', N 38°28' E038°34', N 38°29' E038°35', N 38°29' E038°34', N 38°29' E038°33', 759-818 m, Konacık village, Haydarkulu hamlet and its vicinity N 38°31' E038°33', N 38°31' E038°34', N 38°30' E038°33', N 38°30' E038°32', N 38°30' E038°31', N 38°29' E038°33', 762-922 m, Hacımehmetli village and its vicinity N 38°30' E038°32', N 38°30' E038°31', N 38°29' E038°31', N 38°29' E038°32', 728-790 m, Çiğdemlik village, Hacıyusuflar hamlet and its vicinity N 38°29' E038°30', N 38°30' E038°30', N 38°30' E038°29', N 38°29' E038°29', N 38°31' E038°30', N 38°31' E038°29', N 38°30' E038°28', N 38°31' E038°28', 701-837 m, Karakaş village, İpşir hamlet and its vicinity N 38°32' E038°36', N 38°32' E038°37', 1115-1260 m, Kızıluşağı village and its vicinity N 38°34' E038°40', N 38°34' E038°41' 1303-1356 m, Yalındam village and its vicinity N 38°34' E038°42', 1320-1375 m, Şituşağı village and its vicinity N 38°33' E038°42', N 38°33' E038°41', 1251-1351 m, Söğütdere village and its vicinity N 38°31' E038°41', N 38°32' E038°41', 1174-1210 m Harabekayış village and its vicinity N 38°28' E038°45', N 38°28' E038°44', N 38°27' E038°45', N 38°27' E038°44', N 38°29' E038°45', N 38°30' E038°44', N 38°30' E038°45', 900-1200 m, İmikuşağı village and its vicinity N 38°31' E038°27', N 38°30' E038°28', 724-812 m, Tabanbükü village and its vicinity N 38°31' E038°25', N 38°32' E038°25', N 38°33' E038°25', 730-812 m, Altınuşağı village and its vicinity N 38°32' E038°27', N 38°32' E038°26', 800-950 m, Bilaluşağı village and its vicinity N 38°34' E038°24', N 38°33' E038°24', N 38°34' E038°23', N 38°35' E038°23', N 38°36' E038°23', N 38°36' E038°22', N 38°37' E038°22', N 38°37' E038°23', 722-893 m, Suyatağı village and its vicinity N 38°39' E038°24', N 38°40' E038°25', N 38°40' E038°24', N 38°39' E038°25', N 38°38' E038°23', N 38°37' E038°23', 690-815 m, Höyükköy village and its vicinity N 38°41' E038°29', N 38°40' E038°29', N 38°40' E038°28', 709-740 m, Kumlutarla village and its vicinity N 38°42' E038°30', N 38°43' E038°29', 702-750 m). It was determined that *H. salicifolium*, which is its mycorrhiza, grows naturally from March to May (rarely continue until mid-July) (Table 1, Fig. 4).

T. boudieri samples that were collected in the Elazığ - Malatya area were analysed in detail, both macroscopically and microscopically (ascocarp, peridium, gleba, host plant, hymenium, ascus and ascospore), and the results are presented in Fig. 4.

***Terfezia claveryi* Chatin**

Elazığ city Baskil district (are found in the areas surrounding Gemici village and its vicinity N 38°28' E038°35', N 38°28' E038°34', N 38°29' E038°35', N 38°29' E038°34', N 38°29' E038°33', 759-818 m, Hacımehmetli village and its vicinity N 38°30' E038°32', N 38°30' E038°31', N 38°29' E038°31', N 38°29' E038°32', 728-790 m, Çiğdemlik village, Hacıyusuflar hamlet and its vicinity N 38°29' E038°30', N 38°30' E038°30', N 38°30' E038°29', N 38°29' E038°29', N 38°31' E038°30', N 38°31' E038°29', N 38°30' E038°28', N 38°31' E038°28', 701-837 m, Bilaluşağı village and its vicinity N 38°34' E038°24', N 38°33' E038°24', N 38°34' E038°23', N 38°35' E038°23', N 38°36' E038°23', N 38°36' E038°22', N 38°37' E038°22', N 38°37' E038°23', 722-893 m). It was determined that *H. salicifolium*, which is its mycorrhiza, grows naturally from March to May (Table 1, Fig. 5).

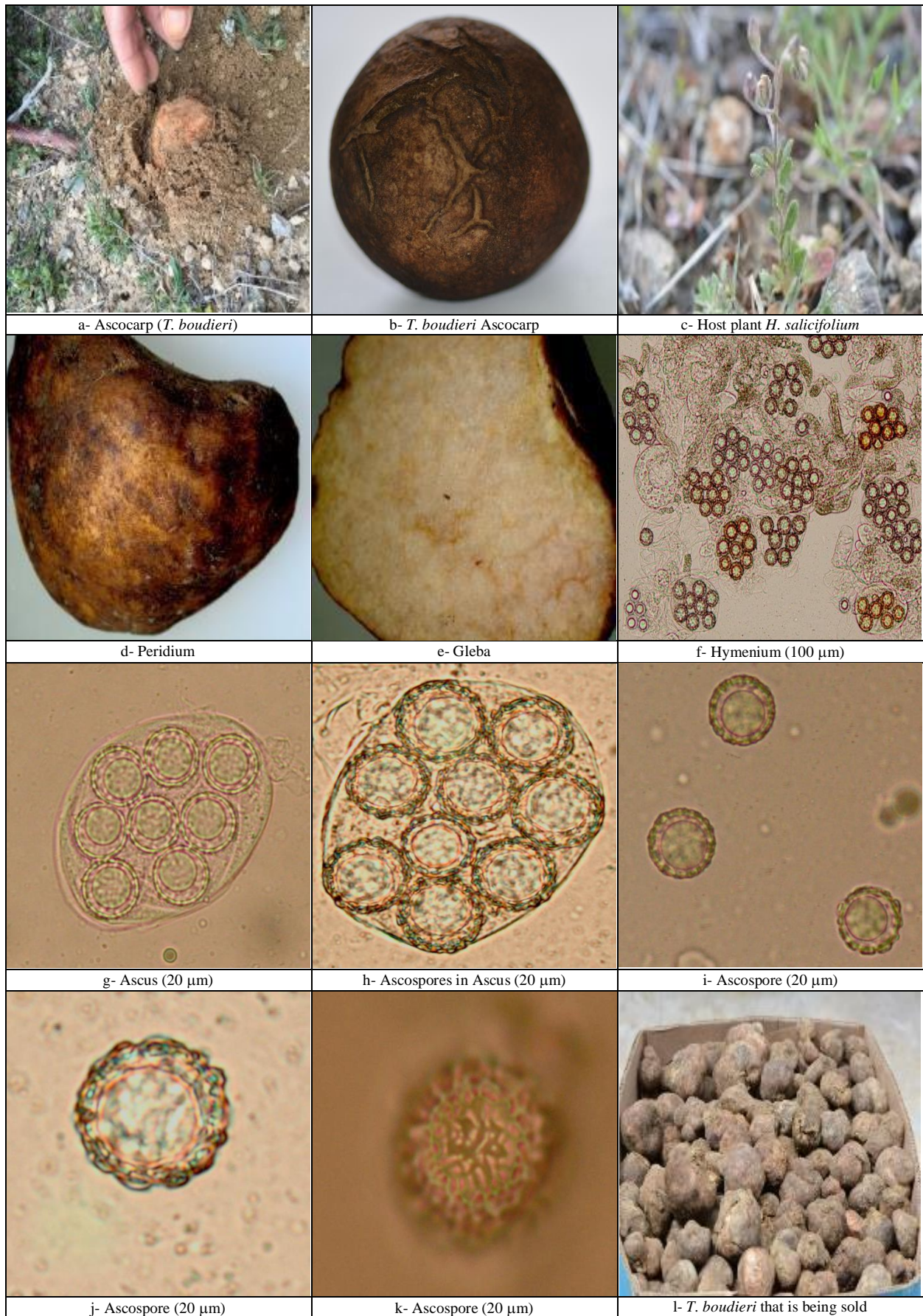


Fig. 4 – The macroscopic and microscopic characteristics (ascocarp, host plant, peridium, gleba, hyphae, hymenium, ascus and ascospore) of *T. boudieri* that were found in the Elazığ - Malatya area.

T. claveryi samples that were collected in the Elazığ area were analysed in detail, both macroscopically and microscopically (ascocarp, peridium, gleba, host plant, hymenium, ascus and ascospore), and the results are presented in Fig. 5.

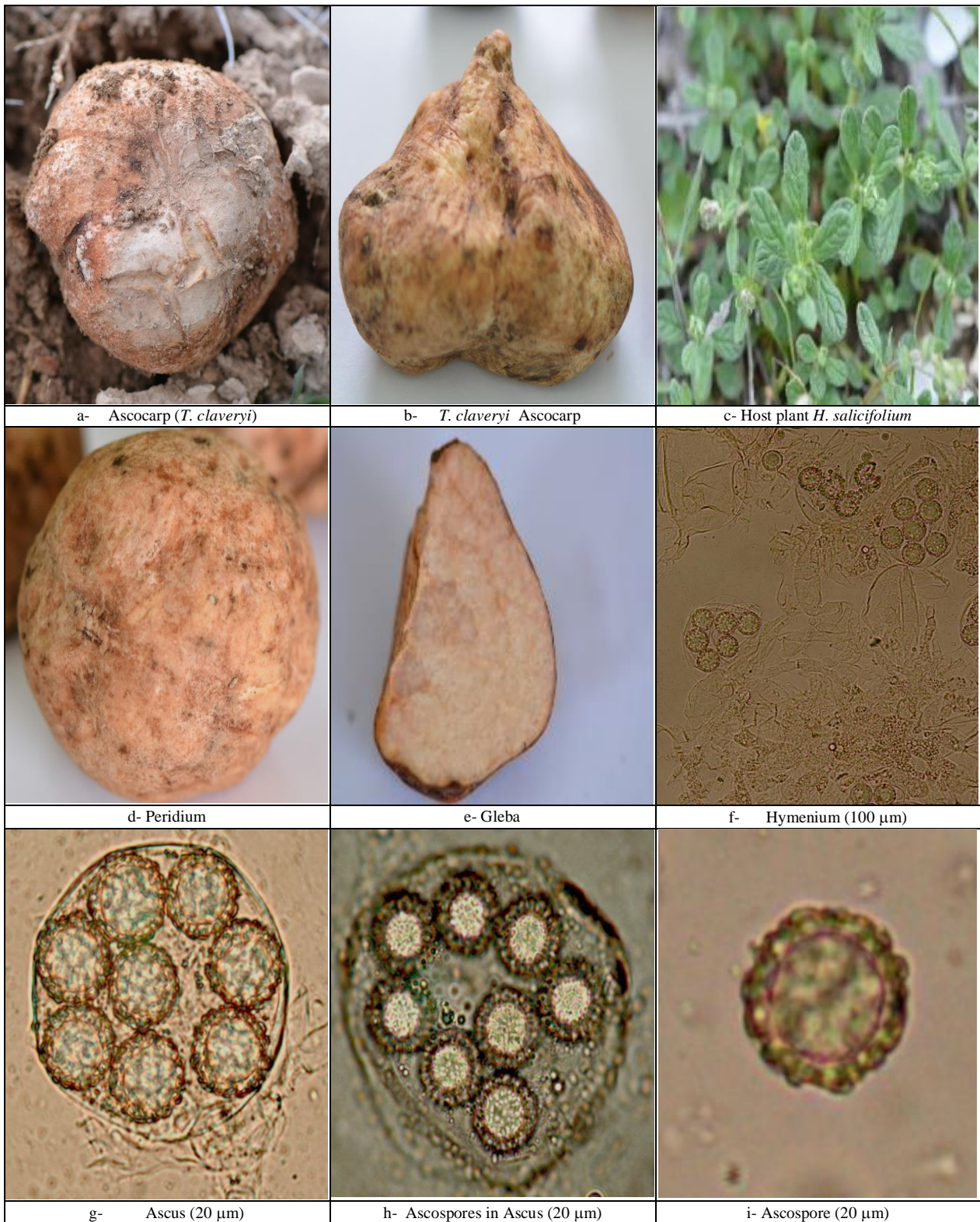


Fig. 5 – The macroscopic and microscopic characteristics (ascocarp, host plant, peridium, gleba, hymenium, ascus and ascospore) of *T. claveryi* that were found in the Elazığ area.

Terfezia olbiensis Tulasne & C.Tulasne

Malatya city Kale district (are found in the areas surrounding Kırıyacak village and its vicinity N 38°23' E038°37', N 38°23' E038°38', N 38°23' E038°39', N 38°24' E038°38', 729-886 m), **Battalgazi district** (are found in the areas surrounding Meydancık village and its vicinity N 38°25' E038°37', N 38°25' E038°38', N 38°24' E038°38', 782-895 m, Yarımcahan village and its vicinity N 38°24' E038°23', N 38°24' E038°24', N 38°24' E038°25', N 38°24' E038°26', N 38°25' E038°24', N 38°25' E038°26', 753-889 m, Çolakoğlu village and its vicinity N 38°26' E038°25', N 38°25' E038°25', N 38°25' E038°24', 715-782 m, Adagören village and its vicinity N 38°26' E038°27', N 38°26' E038°28', 706-763 m, Ağılıyazı village and its vicinity N 38°26' E038°29', N 38°25' E038°28', N 38°25' E038°29', 728-808 m, Kuluşağı village and its vicinity N 38°26' E038°30', N 38°26' E038°31', N 38°26' E038°32', N 38°26' E038°33', 703-764 m, Şişman village and its vicinity N 38°24' E038°34', N 38°24' E038°33', N 38°24' E038°32', N 38°24' E038°31', N 38°25' E038°33', N 38°25' E038°31', N 38°25' E038°30', N 38°25' E038°29', N 38°25' E038°28', 748-881 m). It was determined that *H. salicifolium*, which is its mycorrhiza, grows naturally from March to May (Table 1, Fig. 6).

Elazığ city Baskil district (are found in the areas surrounding Pınarlı village and its vicinity N 38°26' E038°45', N 38°26' E038°44', N 38°26' E038°43', 699-771 m, Kadıköy village and its vicinity N 38°26' E038°42', N 38°26' E038°41', N 38°25' E038°41', 704-806 m, Kuşsarayı village and its vicinity N 38°27' E038°41', N 38°27' E038°40', N 38°27' E038°39', 777-834 m, Alangören village and its vicinity N 38°27' E038°38', N 38°27' E038°37', N 38°28' E038°37', 736-790 m, Deliktaş village and its vicinity N 38°27' E038°37', N 38°28' E038°37', N 38°28' E038°36', N 38°29' E038°37', N 38°29' E038°38', N 38°29' E038°39', 762-1353 m, Gemici village and its vicinity N 38°28' E038°35', N 38°28' E038°34', N 38°29' E038°35', N 38°29' E038°34', N 38°29' E038°33', 759-818 m, Konacık village, Haydarkulu hamlet and its vicinity N 38°31' E038°33', N 38°31' E038°34', N 38°30' E038°33', N 38°30' E038°32', N 38°30' E038°31', N 38°29' E038°33', 762-922 m, Hacımehmetli village and its vicinity N 38°30' E038°32', N 38°30' E038°31', N 38°29' E038°31', N 38°29' E038°32', 728-790 m, Çiğdemlik village, Hacıyusuflar hamlet and its vicinity N 38°29' E038°30', N 38°30' E038°30', N 38°30' E038°29', N 38°29' E038°29', N 38°31' E038°30', N 38°31' E038°29', N 38°30' E038°28', N 38°31' E038°28', 701-837 m, Karakaş village, İpşir hamlet and its vicinity N 38°32' E038°36', N 38°32' E038°37', 1115-1260 m, Söğütderesi village and its vicinity N 38°31' E038°41', N 38°32' E038°41', 1174-1210 m, Harabekayış village and its vicinity N 38°28' E038°45', N 38°28' E038°44', N 38°27' E038°45', N 38°27' E038°44', N 38°29' E038°45', N 38°30' E038°44', N 38°30' E038°45', 900-1200 m, İmikuşağı village and its vicinity N 38°31' E038°27', N 38°30' E038°28', 724-812 m, Tabanbükü village and its vicinity N 38°31' E038°25', N 38°32' E038°25', N 38°33' E038°25', 730-812 m, Altınuşağı village and its vicinity N 38°32' E038°27', N 38°32' E038°26', 800-950 m, Bilaluşağı village and its vicinity N 38°34' E038°24', N 38°33' E038°24', N 38°34' E038°23', N 38°35' E038°23', N 38°36' E038°23', N 38°36' E038°22', N 38°37' E038°22', N 38°37' E038°23', 722-893 m). It was determined that *H. salicifolium*, which is its mycorrhiza, grows naturally from March to May (Table 1, Fig. 6).

T. olbiensis samples that were collected in the Elazığ - Malatya area were analysed in detail, both macroscopically and microscopically (ascocarp, peridium, gleba, host plant, hymenium, ascus and ascospore), and the results are presented in Fig. 6.

Discussion

Picoa lefebvrei, *P. juniperi*, *Terfezia boudieri*, *T. claveryi* and *T. olbiensis* were collected from the field during our work. The morphological, ecological characteristics of the truffles, and the characteristics of the areas they grow were documented (Table 1). The required macroscopic and microscopic data were gathered using standard micological techniques (Trappe 1979, Alsheikh 1994, Montecchi & Sarasini 2000, Ferdman et al. 2005, Castellano & Türkoğlu 2012, Türkoğlu & Castellano 2014). The data, which was collected after the fieldwork and laboratory studies, were evaluated, the species were defined using the relevant literary sources (Alsheikh & Trappe 1983, Gücin 1983, Alsheikh 1994, Moreno et al. 2000, Montecchi & Sarasini 2000, Kirk et al. 2008,



Fig. 6 – The macroscopic and microscopic characteristics (ascocarp, host plant, peridium, gleba, hyphae, hymenium, ascus and ascospore) of *T. olbiensis* that were found in the Elazığ - Malatya area.

Kagan-Zur et al. 2014), and the definitions were verified based on the works of Gücin (1983), Gücin et al. (2010), Türkoğlu & Castellano (2014), and Türkoğlu et al. (2015).

Picoa lefebvrei grows naturally at Elazığ, Şanlıurfa, Denizli, Aksaray and Konya (Gücin et al. 2010, Şahin 2012, Türkoğlu et al. 2015), *P. juniperi* grows naturally at Kayseri, Uşak, Denizli, Nevşehir, Konya, Elazığ, Afyonkarahisar and Antalya (Türkoğlu & Yağız 2012, Türkoğlu & Castellano 2014, Türkoğlu et al. 2015), *Terfezia arenaria* grows naturally at Aydın, Isparta, Malatya and Konya (Öder 1988, Işıloğlu & Öder 1995, Afyon 1996, Kaşık et al. 1998, Türkoğlu et al. 2015), *T. claveryi* grows naturally at Denizli, Şanlıurfa, Konya, Aksaray, Diyarbakır, Karaman, Yozgat, Konya and Kastamonu (Bekçi et al. 2011, Şahin 2012, Türkoğlu et al. 2015), *T. leptoderma* grows naturally at Uşak and Denizli (Castellano & Türkoğlu 2012; Türkoğlu & Castellano 2014), *T. olbiensis* grows naturally at Uşak, Konya and Nevşehir (Türkoğlu & Castellano 2014), *T. boudieri* grows naturally at Uşak, Batman, Karaman, Elazığ, Malatya, Eskişehir, Mardin, Şanlıurfa, Diyarbakır, Niğde, Gaziantep, Konya, Ankara, Kutahya, Aksaray, Kırşehir etc. (Gücin 1983, Gücin 1990, Gücin & Dülger 1997, Kaşık et al. 2001, Doğan & Öztürk 2006, Demir et al. 2007, Aydın 2009, Akyüz et al. 2012, Şahin 2012, Türkoğlu & Yağız 2012, Yamaç 2012 etc.), which are arid, semi-arid truffle types. It was determined that *P. lefebvrei*, *P. juniperi*, *T. olbiensis*, *T. claveryi* and *T. boudieri* (Figure 2-6) grow naturally at the area, where the Malatya (Merkez, Kale, Battalgazi, Arguvan districts and their vicinities) and Elazığ (Baskil district and its vicinity) provincial borders intersect, together with the area around Kömürhan Bridge, and at areas along the shores of the Karakaya Dam, as seen in Table 1 and Fig. 1.

Desert truffle types grow at parts of the Mediterranean region with arid or semi arid conditions, and represented by types including *Terfezia*, *Tirmania* and *Picoa*. These exist as mycorrhizae with the roots of plant types of the Cistaceae family, of which various species of the *Helianthemum* (L.) genus are a part of, and which exist in areas where different soil characteristics can be observed (Diez et al. 2002, Gutierrez et al. 2003, Mandeel & Al-Laith 2007, Kagan-Zur & Roth-Bejerano 2008, Morte et al. 2008, Kovacs et al. 2011, Chevalier 2014, Kagan-Zur et al. 2014, Roth-Bejerano et al. 2014). It was determined that *Picoa lefebvrei*, *P. juniperi*, *Terfezia boudieri*, *T. claveryi* and *T. olbiensis* naturally grow usually at areas where *Helianthemum salicifolium*, and rarely at areas where *Helianthemum ledifolium* exist within the study area (Table 1, Fig. 2d, 3d-e, 4c, 5c, and 6d).

Picoa lefebvrei has a pale yellow-brown to yellow-brown peridial surface with scattered to numerous, irregular warts, while *P. juniperi* has a brown-black to black peridial surface with regularly arranged and uniformly distributed warts (Türkoğlu et al. 2015). *Terfezia olbiensis* has small ascocarps with pale colours and also fairly short spores ornamented with narrow to broadly truncate cones. It appears to be the most uncommon of the *Terfezia* species found in Turkey. Montecchi and Sarasini (2000) reported *T. olbiensis* from under *Quercus* or *Pinus* spp., but our specimens and examples found by some researchers were found in sandy soils associated with *Helianthemum* spp. (Türkoğlu & Castellano 2014). *Terfezia claveryi* has an off-white peridial surface at first but later has a red-brown, finally dark red brown or black-brown peridial surface. It has a pale yellow gleba with distinct sterile veins. It has spores ornamented with a prominent irregular reticulation with irregular alveolae (Türkoğlu et al. 2015).

Terfezia boudieri is a species close to *T. claveryi*, and some authors consider them synonyms. In any case, their macro-morphological nature, ecology, hosts, fruiting periods, etc. are extremely similar. The greatest morphometric difference is noted at a microscopic level and lies in spore ornamentation. In *T. claveryi*, the spore presents a well-defined reticulum upon which slightly prominent warts might appear in accordance with the degree of maturity, whereas pronounced and sometimes truncated warts appear in the spores of *T. boudieri*, which resemble those of *T. arenaria*. This character is insufficient to separate both species because of a possible continuum between the ornamentation of one species and that of the other, given the presence of verrucose growths on the reticulum nodes of the *T. claveryi* spores (Morte et al. 2009). In some parts of Elazığ and Malatya, it is quite possible to find carpophores of *T. boudieri* mixed with those of *T. claveryi* since even the rural population cannot distinguish between the two species.

It was observed that in all research areas, *Terfezia boudieri* and *Picoa lefebvrei* were found in the same growing areas, and at some areas both *Terfezia* and *Picoa* species were found together (Table 1). It is highly possible that with more fieldwork and longterm research, other types of these species can also be found in these areas. In conclusion, we report the first records of two *Terfezia* species (*T. olbiensis* and *T. claveryi*) in the research field, and that we determined new areas for *Terfezia boudieri*, *Picoa juniperi* and *P. lefebvrei* in the Malatya and Elazığ provinces. Furthermore, the habitats of these species should be protected by turning the growing fields into natural protected areas, in order to assure that new generations can also exploit these semi-arid truffles, which grow at a certain location only during a certain part of the year, and consumed by the locals as a daily source of nutrition.

Acknowledgements

We would like to thank The Scientific and Technical Research Council of Turkey (TÜBİTAK) for financially supporting this project (TOVAG-114O065). We wish to express our sincere gratitude to Dr. Aziz Türkoğlu (Muğla Sıtkı Koçman University, Turkey), Dr. Varda Kagan Zur (Ben Gurion University, Israel), and Dr. T. Emre Şerifoğlu (Bitlis Eren University, Turkey) for their valuable comments and suggestions.

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