

The lichenicolous fungi of Burdur province in Turkey

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ABSTRACT — In the course of studies of lichens and bryophytes of Burdur province, Turkey, 42 species of lichenicolous fungi belonging to 20 genera in *Ascomycota* and *Basidiomycota* have been identified. Three of them, *Dactylospora parellaria*, *Didymellopsis perigena*, and *Zwackhiomacromyces constrictocarpus*, are new to Turkey in particular and Asia in general; short descriptions and distributional data are presented. In addition, the Turkish material of *Z. constrictocarpus*, hitherto only known from the type collection in Spain, represents the second record of this species.

KEY WORDS — ascomycetes, lichen-inhabiting, biodiversity, new records, Turkey

Introduction

Lichenicolous fungi, many of them of unknown phylogenetic position, growing as obligate parasites or saprotrophs on lichens, constitute a large group of about 1.800 taxa (Lawrey & Diederich 2011). Most of them belong to *Ascomycota* (about 95 %), and the rest to *Basidiomycota* (Lawrey & Diederich 2003). Although the number of studies on lichenicolous fungi in Turkey has been increasing in recent years (Candan & Halici 2009, Etayo & Yazici 2009, Halici 2008, Halici et al. 2007, 2010a, b, Yazici & Etayo 2013, 2014, Yazici et al. 2011), this fungal group remains insufficiently examined in this country. Only three lichenicolous fungi (*Buelliella poetschii*, *Codonmyces lecanorae* and *Polycoccum pulvinatum*) have been reported from Burdur province so far (Yazici & Etayo 2013) while approximately 146 lichenicolous fungi have thus far been found in other regions of Turkey (Halicı et al. 2010b, Yazici & Etayo 2014, Yazici et al. 2011). This number is small in comparison with those of some better studied European countries (Fałtynowicz 2003, Hawksworth 2003, Kocourková 2000, Scholz 2000, Santesson et al. 2004), reflecting the fact that many regions of Turkey are still unexplored. Herewith we report forty-two species new to this area, including three species which are even new to Turkey and Asia in general.

Material and methods

Specimens were collected by the first author, Kenan Yazici, from 41 sites in Burdur region in the course of lichenological field studies carried out between 2012 and 2013 (Figure 1, Table 1). Hand-cut sections were examined microscopically in water (including all measurements), 10% KOH, and lactophenol cotton blue. Air-dried samples were observed using a Nikon SMZ1500 stereomicroscope and a Nikon Eclipse 80i light microscope for ascospores and apothecial sections. Nomenclature and species concepts follow Alstrup & Hawksworth 1990, Alstrup et al. 2009, Atienza et al. 2003, Clauzade et al. 1989, Calatayud & Etayo 1999, Calatayud & Barreno 2003, Calatayud et al. 2002, Etayo 2010, Etayo & Sancho 2008, Hafellner et al. 2008, Hawksworth et al. 2010, Hawksworth 1983, 2003, Hawksworth & Diederich 1988, Ihlen et al. 2004, Ihlen & Wedin 2007, van den Boom & Etayo 2014. Vouchers specimens are stored in the herbarium of Department of Biology, Faculty of Science, Karadeniz Technical University, Trabzon, Turkey (KTUB).

Study area

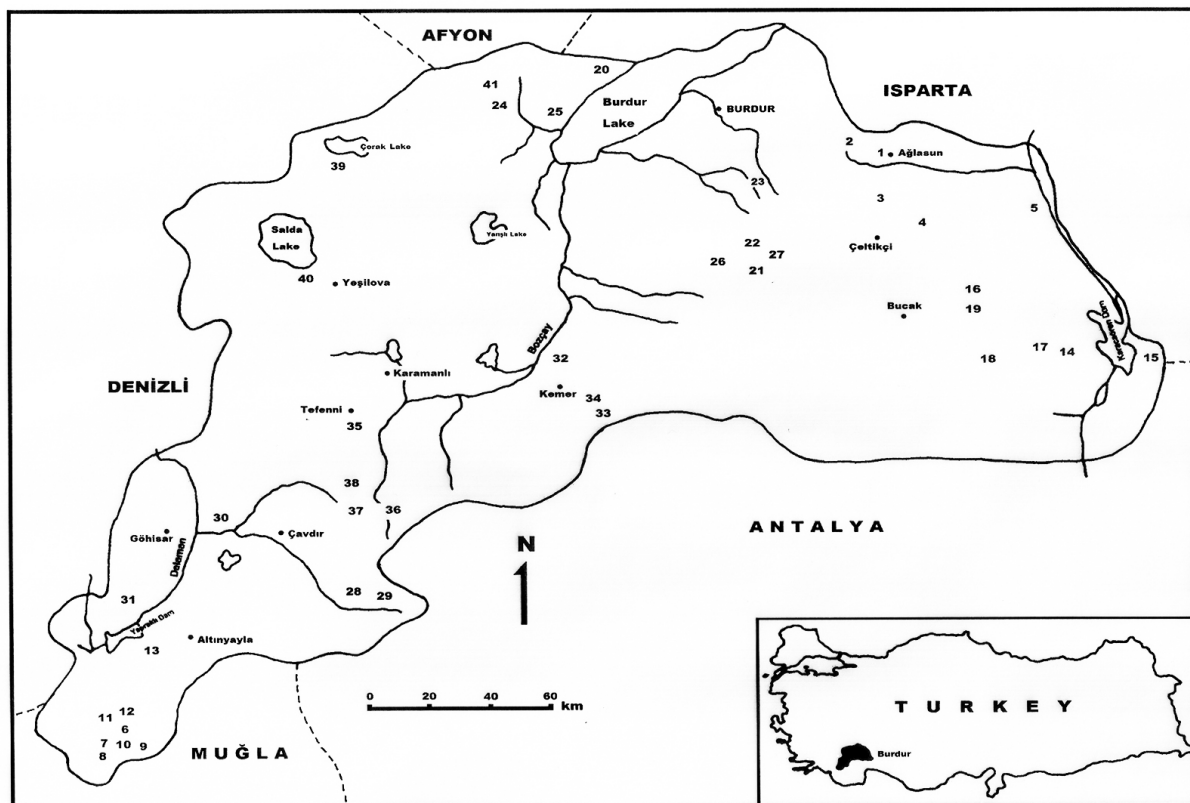
Burdur has a continental Mediterranean climate with cold snowy winters and very hot long and dry summers. The temperature ranges from -16 to 39°C with a mean of 15°C; the annual rainfall averages 468 mm and the average humidity is 51.2% (Akman 1999).

In terms of the amount of forest cover (47%) Burdur province is not particularly rich, and dominated by *Abies*, *Cedrus*, *Ficus*, *Fraxinus*, *Juniperus*, *Liquidambar*, *Olea*, *Pinus*, *Pistacia*, *Platanus*, *Prunus*, *Salix*, *Quercus* and *Rhus* spp. Especially Altınyayla district, surrounding Yapraklı Dam, and Karacaören Dam in Bucak district is richer than the other parts of the region with regard to deciduous and coniferous trees (Baytop & Denizci 1963). Additionally the mountains are formed by marble rocks. In general, the lichen diversity can be classified to be moderately rich, which might be attributable to the Mediterranean climate of the area and the amount of deciduous and coniferous trees.

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Burdur province (Turkey) with localities of lichenicolous fungi collected under this study.
(See Table 1 for details)

Results

The following is a list of lichenicolous fungi collected from 41 sites in the Burdur region of Turkey during the study. Site locations are given in Table 1.

Abrothallus parmeliarum (Sommerf.) Nyl. – [Loc. 8], (KTUB 2365), on thalli of *Parmelia saxatilis* (L.) Ach.

Abrothallus tulasnei M.S. Cole & D. Hawksw – [Loc. 15], (KTUB 2370), on thallus of *Xanthoparmelia tinctina* (Maheu & A. Gillet) Hale

Arthonia clemens (Tul.) Th. Fr. – [Loc. 30], (KTUB 2369), on thallus and apothecia of *Rhizoplaca melanophthalma* (DC.) Räsänen.

Arthonia epiphyscia Nyl. – [Loc. 12], (KTUB 2366), on thallus of *Physcia biziana* (A.Massal.) Zahlbr.

Arthonia hertelii (Calat., Barreno & V.J. Rico) Hafellner & V. John – [Loc. 8], (KTUB 2414), on thallus of *Aspicilia* sp.

Arthonia molendoi (Heufl. ex Frauenf.) R. Sant. – [Loc. 32], (KTUB 2368), on apothecia of *Caloplaca lobulata* (Flörke) Hellb.

Arthonia phaeophysciae Grube & Matzer – [Loc. 13], (KTUB 2413), on thallus of *Phaeophyscia orbicularis* (Neck.) Moberg

Arthonia varians (Davies) Nyl. – [Loc. 24], (KTUB 2367), on thallus and apothecia of *Lecanora rupicola* (L.) Zahlbr. and *Lecanora swartzii* (Ach.) Ach.

Biatoropsis usnearum Räsänen – [Loc. 12], (KTUB 2371), on thallus of *Usnea lapponica* Vain.

Caloplaca grimmiae (Nyl.) H. Olivier – [Loc. 1], (KTUB 2405); [Loc. 3], (KTUB 2406); [Loc. 4], (KTUB 2407); [Loc. 5], (KTUB 2412); [Loc. 16], (KTUB 2409); [Loc. 28], (KTUB 2411); [Loc. 28], (KTUB 2410); [Loc. 39], (KTUB 2408), on thalli and apothecia of *Candelariella vitellina* (Ehrh.) Müll.Arg.

Carbonea supersparsa (Nyl.) Hertel – [Loc. 35], (KTUB 2404), on thallus of *Pertusaria albescens* (Huds.) M.Choisy & Werner

Carbonea vitellinaria (Nyl.) Hertel – [Loc. 2], (KTUB 2372), on thallus of *Candelariella vitellina*.

Cercidospora macrospora (Uloth) Hafellner & Nav.-Ros. – [Loc. 29], (KTUB 2403), on thallus and apothecia of *Protoparmeliopsis muralis* (Schreb.) M. Choisy

Cercidospora melanophthalmae Nav.-Ros., Calat. & Hafellner – [Loc. 35], (KTUB 2373), on thallus and apothecia of *Rhizoplaca melanophthalma*.

Cercidospora xanthoriae (Wedd.) R. Sant. – [Loc. 29],], (KTUB 2441), on thallus and apothecia of *Xanthoria elegans* (Link) Th.Fr.

Dactylospora homoclinella (Nyl.) Hafellner – [Loc. 40], (KTUB 2375), on thallus of *Aspicilia contorta* Körb. subsp. *hoffmanniana* S.Ekman & Fröberg ex R.Sant.

Dactylospora parellaria (Nyl.) Arnold – [Loc. 29], (KTUB 2374), on thallus of corticolous *Lecanora* sp.

This species was described in detail by Ihlen & Wedin (2008).

Ascomata margin smooth, round or ± elliptic, 0.25–0.60 mm diam., exciple 60–95 µm wide, hypothecium light brown, ascospores to 3-septate, 8–13.5(–15) × (3.5–)4–6 µm, elliptic, In Turkey, this species was mainly found in coastal habitats. New to Turkey and Asia in general. Hitherto known from Austria, British Isles, Canada, France, Portugal, Spain (Ihlen et al. 2004, Ihlen & Wedin 2008).

Didymellopsis perigena (Nyl.) Grube & Hafellner – [Loc. 8], (KTUB 2402), on thalus of *Endocarpon* sp.

This species was described in detail by Grube & Hafellner (1990).

Ascomata perithecioid, 145–245 µm in diam., globose to pear-shaped, formed near the edges of the thalli. Peridium brown, basal 30–40(–45) µm, apical 35–40 µm thick. Asci 6–8-spored, fissitunicate, clavate-cylindrical, 65–80 × 11–13 µm. Ascospores fusiform, hyaline, one septate, upper cell ± longer, 18–24 × 7–8 µm. New to Turkey and the Middle East in general. Hitherto known from Asia, Africa, and Europe (Etayo 2008, Etayo & Breuss 1998, Grube & Hafellner 1990, Roux 2012).

Endococcus rugulosus (Borrer ex Leight.) Nyl. – [Loc. 10], (KTUB 2376), [Loc. 39], (KTUB 2378), on thalli of *Aspicilia cinerea* (L.) Körb.

Endococcus stigma (Körb.) Stizenb. – [Loc. 10], (KTUB 2401), on thallus and apothecia of *Acarospora* sp.

Lichenconium lecanorae (Jaap) D. Hawksw. – [Loc. 29], (KTUB 2379), on thallus and apothecia of *Rhizoplaca chrysoleuca* (Sm.) Zopf

Lichenconium lichenicola (P. Karst.) Petr. & Syd. – [Loc. 12], (KTUB 2400), on thallus of *Physcia aipolia* (Ehrh. ex Humb.) Fűrnr.

Lichenconium pyxidatae (Oudem.) Petr. & Syd. – [Loc. 30 and 36], (KTUB 2377, 2437), on podetia of *Cladonia pyxidata* (L.) Hoffm.

Lichenostigma alpinum (R. Sant., Alstrup & D. Hawksw.) Ertz & Diederich – [Loc. 26], (KTUB 2389), on apothecia of *Lecanora varia* (Hoffm.) Ach.

Lichenostigma elongatum Nav.-Ros. & Hafellner – [Loc. 18, 29, 36 and 37], (KTUB 2383, 2438), on thalli of *Lobothallia radiosa* (Hoffm.) Hafellner; [Loc. 24, 27, 38 and 39], (KTUB 2397, 2439), on thalli of *Aspicilia* sp.; [Loc. 25], (KTUB 2399), on thalli of *Aspicilia calcarea* (L.) Körb. and *Aspicilia contorta* (Hoffm.) Körb. subsp. *contorta*.

Lichenostigma rouxii Nav.-Ros., Calat. & Hafellner – [Loc. 30 and 36], (KTUB 2382, 2434), on thalli of *Squamarina cartilaginea*. (With.) P.James

Lichenostigma rupicolae Fern.-Brime & Nav.-Ros. – [Loc. 12], (KTUB 2396), on thallus of *Pertusaria* sp.

Lichenostigma triseptatum Halici & D. Hawksw. – [Loc. 1], (KTUB 2380), on thallus of *Aspicilia caesiocinerea* (Nyl. ex Malbr.) Arnold

Muellerella erratica (A. Massal.) Hafellner & V. John – [Loc. 14, 22 and 26], (KTUB 2398, 2436), on thalli of *Aspicilia calcarea*; [Loc. 22], (KTUB 2395), on thallus of *Aspicilia* sp.; [Loc. 26], (KTUB 2381), on thallus of *Lecidella stigmata* (Ach.) Hertel & Leuckert

Muellerella pygmaea (Körb.) D. Hawksw. var. *pygmaea* – [Loc. 6], (KTUB 2415), on thallus of *Lecidella patavina* (A.Massal.) Knoph & Leuckert; [Loc. 7], (KTUB 2385), on thallus of *Lobothallia radiosa*; [Loc. 19], (KTUB 2416), on thallus of *Lecidea fuscoatra* (L.) Ach.; [Loc. 20], (KTUB 2419), on thallus of *Lecidella patavina*; [Loc. 25], (KTUB 2418), on thallus of *Aspicilia contorta* subsp. *contorta*; [Loc. 26], (KTUB 2417), on thallus of *Lecidella patavina*; [Loc. 21], (KTUB 2386), on thallus of *Aspicilia* sp.; [Loc. 34], (KTUB 2393), on thallus of *Lecanora* sp.; [Loc. 34], (KTUB 2384), on thallus of *Aspicilia* sp.

Muellerella lichenicola (Sommerf.) D. Hawksw. – [Loc. 1], (KTUB 2392), on thallus of *Aspicilia caesiocinerea*.

Muellerella ventosicola (Mudd) D. Hawksw. – [Loc. 24], (KTUB 2394), on thallus of *Rhizocarpon geographicum* (L.) DC.

Phacopsis oxyspora (Tul.) Triebel & Rambold – [Loc. 10, 17], (KTUB 2391), on thalli of *Parmelia* sp.

Phacopsis vulpina Tul. – [Loc. 9,11], (KTUB 2387), on thalli of *Letharia vulpina* (L.) Hue

Rhymbocarpus geographicici (Stein) Vouaux – [Loc. 39], (KTUB 2361), on thallus of *Rhizocarpon geographicum*.

Rimularia insularis (Nyl.) Rambold & Hertel – [Loc. 24], (KTUB 2388), on thallus of *Lecanora rupicola*.

Stigidium allogenum (Nyl.) D. Hawksw. – [Loc. 9], (KTUB 2360), on thallus of *Psora decipiens* (Hedw.) Hoffm.

Vouauxiella lichenicola (Linds.) Petr. & Syd. – [Loc. 23, 26, 27 and 41], (KTUB 2390, 2433), on apothecia of *Lecanora chlarotera* Nyl.

Zwackhiomacromyces constrictocarpus Etayo & van den Boom – [Loc. 33], (KTUB 2420), on thallus of *Megaspora verrucosa* (Ach.) Hafellner & V.Wirth

This species was described in detail by van den Boom and Etayo (2014). Ascomata perithecioid, 200–300 µm diam., wall dark brown, pseudoparenchymatous cells 12–17 × 4–6 µm, the outermost layer, 16–22 µm thick, black, pyriform, constricted below the papille. Hamathecium persistent, composed of branched and anastomosed pseudoparaphyses, lacking paraphyses and paraphysoids. Asci (6–)8-spored, elongate-clavate, fissitunicate. Ascospores ellipsoid to broadly ellipsoid, rounded at the apices, hyaline, lacking a conspicuous sheath, 32–46 × 13.5–18(–20) µm. New to Turkey in particular and Asia in general. The Turkish collection of *Z. constrictocarpus*, described and hitherto only known from Spain (van den Boom & Etayo 2014), represents the second record of this species.

Zwackhiomyces coepulonius (Norman) Grube & R.Sant. – [Loc. 26], (KTUB 2363), on thallus and apothecia of *Xanthoria elegans*

Zwackhiomyces lecanorae (Stein) Nik. Hoffm. & Hafellner – [Loc. 22], (KTUB 2364), on apothecia of *Lecanora dispersa* (Pers.) Röhl.

Zwackhiomyces lithoicae (B. de Lesd.) Hafellner & V. John – [Loc. 31], (KTUB 2362), on thallus of *Aspicilia calcarea*.

Discussion

Forty-two species of lichenicolous fungi belonging to 20 genera have been identified among examined material recently found in Burdur Province in Turkey. Three species – *Dactylospora parellaria*, *Didymellopsis perigena*, and *Zwackhiomacromyces constrictocarpus* – are new to Turkey in particular and Asia in general. *Z. constrictocarpus* was hitherto only known from the type locality in Spain, where it was also found on *Megaspora verrucosa*. All taxa recorded from Burdur Province were found on 38 different hosts.

Three lichenicolous taxa were found on *Aspicilia* sp. and two on *Aspicilia calcarea*, *Aspicilia caesiocinerea*, *Candelariella vitellina*, *Lecanora rupicola*, *Lobothallia radiosa*, *Rhizocarpon geographicum*, *Rhizoplaca melanophthalma*, and *Xanthoria elegans* while only one taxon was collected on *Acarospora* sp., *Lecidella stigmata*, *Aspicilia contorta* subsp. *hoffmanniana*, *Aspicilia cinerea*, *Caloplaca lobulata*, *Cladonia pyxidata*, *Endocarpon* sp., *Lecanora* sp., *Lecanora swartzii*, *Letharia vulpina*, *Lecanora varia*, *Lecanora chlorotera*, *Lecanora dispersa*, *Lecidella patavina* *Lecidea fuscoatra*, *Aspicilia contorta* subsp. *contorta*, *Megaspora verrucosa*, *Physcia biziana*, *Pertusaria albescens*, *Protoparmelia muralis*, *Pertusaria* sp., *Parmelia* sp., *Parmelia saxatilis*, *Psora decipiens*, *Physcia aipolia*, *Rhizoplaca chrysoleuca*, *Squamarina cartilaginea*, *Usnea lapponica*, and *Xanthoparmelia tinctina*.

Caloplaca grimmiae, *Lichenostigma elongatum*, *Muellerella pygmaea*, and *Muellerella erratica* are the most common lichenicolous fungi. *Lichenostigma elongatum* and *Muellerella pygmaea* were found in 9 localities while *Caloplaca grimmiae* in 8 localities and *Muellerella erratica* in 5 localities.

Arthonia molendoi, *Lichenostigma alpinum*, *Vouauxiella lichenicola*, and *Zwackhiomyces lecanorae* were found on apothecia of hosts, while 27 taxa were found only on lichen thalli, and 10 lichenicolous fungi inhabited both thalli and apothecia.

The host preference of lichenicolous fungi was found to be mainly identical to that reported in the literature (Hawksworth et al. 2010, Ihlen et al. 2004, Grube & Hafellner 1990, Hawksworth 2003, Etayo & Sancho 2008, Halici 2008). *Lichenostigma elongatum*, *Muellerella erratica* and *Muellerella pygmaea* were found to be the most indifferent species as far as host selectivity is concerned.

The genera *Arthonia* Ach. (represented by 6 species), *Lichenostigma* Hafellner (5), *Muellerella* Hepp ex Müll.Arg. (4), *Cercidospora* Körb. (3), *Lichenocodium* Petr. & Syd. (3), and *Zwackhiomyces* Grube & Hafellner were the most diverse in the studied area.

We found six lichenicolous fungi at site 26; five species at site 29 and four species at sites 1, 12, 24, 39. Burdur province does not belong to the richest regions in terms of the amount of forest cover (see Study area) except for Altınyayla and Bucak districts surrounding the dams of Yapraklı and Karacaören, respectively. The lichen diversity is generally moderately rich, which might be attributable both to the Mediterranean climate of the area and the combination of deciduous and coniferous trees.

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Table 1. Collecting localities of Burdur province (Turkey)

No.	Locality	Coordinate	Altitude (m)	Date
1	Ağlasun, exit of Ağlasun	37°39'40.86"N/ 30°31'16.53"E	1236	17.07.2012
2	Ağlasun, exit of Yeşilbaşköy	37°38'51.70"N/ 30°27'23.57"E	1452	17.07.2012
3	Ağlasun, Kiprit	37°35'53.16"N/ 30°30'06.06"E	1133	05.07.2014
4	Ağlasun:Çanaklı	37°34'09.85"N/ 30°34'05.09"E,	1151	05.07.2014
5	Ağlasun, Aşağı Yumrutaş	37°34'50.79"N/ 30°43'42.77"E	691	07.07.2014
6	Altınyayla, Ballık	36°57'16.87"N/ 29°27'28.69"E	1432	11.06.2013
7	Altınyayla, entrance to Karanlıkdere valley	36°51'20.87"N/ 29°25'16.33"E	1349	23.08.2013
8	Altınyayla, Karanlıkdere canyon	36°49'32.89"N/ 29°24'31.07"E	1429	23.08.2013
9	Altınyayla, Karanlıkdere canyon, towards control tower, roadside	36°50'01.31"N/ 29°24'56.59"E	1392	23.08.2013
10	Altınyayla, exit of Ballık, along Karanlıkdere valley	36°51'49.52"N/ 29°25'31.31"E	1357	23.08.2013
11	Altınyayla, opposite of Ballık, the end of Boncuk mountain	36°53'20.88"N/ 29°25'25.20"E	1555	11.06.2013
12	Altınyayla, 5 km to Ballık	36°56'23.58"N/ 29°27'02.49"E	1418	08.04.2013
13	Altınyayla, exit of Çörten	36°59'06.50"N/ 29°29'06.33"E	1114	11.06.2013
14	Bucak, between Isparta-Antalya road and Pamucak, Çobanpınar	37°23'39.42"N/ 30°46'50.60"E	600	17.07.2012

Table 1. continued

No.	Locality	Coordinate	Altitude (m)	Date
15	Bucak, Kızıllı village	37°23'07.11"N/ 30°53'34.29"E	485	18.07.2012
16	Bucak, Kema	37°28'57.55"N/ 30°39'06.27"E	1180	28.06.2012
17	Bucak, towards Telciler village, along valley	37°22'34.88"N/ 30°43'55.53"E	756	26.06.2013
18	Bucak, exit of Yukarı kuyubaşı valley	37°21'51.07"N/ 30°42'15.03"E	975	24.08.2012
19	Bucak, between Burdur-Bucak road, enter to Beşkonak	37°25'46.94"N/ 30°40'14.53"E,	806	25.06.2012
20	Center, Ilyas village (North of Burdur lake)	37°46'40.42"N/ 30°08'23.20"E	955	25.06.2013
21	Center, Akyayla (Katrancık= Kestel mountain's skirt)	37°30'05.84"N/ 30°20'06.83"E	1435	26.08.2012
22	Center, between Bereket and Kayış viilages	37°32'40.76"N/ 30°19'19.70"E	1472	27.06, 2012,
23	Center, Kayaaltı village	37°37'06.72"N/ 30°20'37.41"E	1248	18.07.2012
24	Center, towards Ulupınar village, roadside	37°44'39.99"N/ 30°00'01.80"E	1434	25.06.2013
25	Center, exit of Karakent (South-west of Burdur lake)	37°43'50.59"N/ 30°06'16.99"E	883	25.06.2013
26	Center, Katrancı mountain-1	37°30'41.71"N/ 30°18'36.97"E	1505	10.04.2013
27	Center, Katrancı mountain-2	37°29'48.34"N/ 30°21'04.64"E	1529	25.09.2013
28	Çavdır, Yazır (Göllük) village, roadside	37°02'22.45"N/ 29°45'14.28"E	1289	09.06.2013
29	Çavdır, between Çavdır and Söğüte, roadside	37°02'26.99"N/ 29°47'21.74"E	1432	09.06.2013

Table 1. continued

No.	Locality	Coordinate	Altitude (m)	Date
30	Göhlhisar, between Çavdır and Göhlhisar, 5 km to Göhlhisar	37°08'59.17"N/ 29°36'4071"E	970	29.06.2012
31	Göhlhisar, along side of Yapraklı Dam	37°02'43.42"N/ 29°27'49.94"E	1055	29.06.2012
32	Kemer, 3 km to Kemere	37°23'08.61"N/ 30°02'56.32"E	1065	07.04.2013
33	Kemer, Bozdağ	37°19'04.39"N/ 30°05'35.38"E	1580	24.09.2013
34	Kemer, 3 km to Bozdağ, Bozdağ- Akpınar plateau	37°19'37.13"N/ 30°04'44.96"E	1425	07.04.2013
35	Tefenni, exit of Tefenni	37°18'56.25"N/ 29°45'35.66"E	1210	19.07.2012
36	Tefenni, Yeşilköy	37°10'41.65"N/ 29°49'02.48"E	1483	21.08.2013
37	Tefenni, Başpınar village	37°10'43.40"N/ 29°46'06.85"E	1237	21.08.2013
38	Tefenni, Yuva village	37°12'50.52"N/ 29°45'22.77"E	1243	21.08.2013
39	Yeşilova, South of Çorakgöl lake, Bayındır village	37°40'03.41"N/ 29°44'29.55"E	1005	12.06.2013
40	Yeşilova, South of Salda lake	37°30'38.51"N/ 29°41'33.31"E	1180	19.07.2012
41	Yeşilova, between Ulupınar and Elden villages	37°45'00.76"N/ 29°58'10.63"E	1563	25.06.2013