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Species of *Camarosporium* on Forest Trees and Shrubs New Reports from Anatolian Peninsula

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Abstract: *During a diversity survey of dendrocolous fungi in Kırşehir Province of Turkey, many coelomycete specimens were collected in 2012– 2014. Among them six new records of Camarosporium species from Anatolian Peninsula are reported here. They are Camarosporium astragalinum, C. cruciatum, C. kirchneri, C. multiforme, C. polymorphum and C. ulmi. The brief description and illustration of microscopic characters are provided for these taxa based on Turkish specimens.*

Keywords: *Ascomycota, biodiversity, anamorphic fungi, taxonomy.*

1. INTRODUCTION

The genus *Camarosporium* was introduced by Schulzer [1] with *C. quaternatum* Schulzer as the type species. Currently, there are more than 500 names listed in the genus [2]. Members of *Camarosporium* ssp. have a world wide distribution and commonly inhabit branches and leaves as saprobes of a wide range of hosts [3, 4]. Zachos et al. [5] and Holevas et al. [6] have reported that *C. pistaciae* Zachos, Tzav.-Klon. & Roubosis a fungal plant pathogen that causes blight in pistachio shoots and panicles. Hüseyinov [7] and Hüseyin & Yıldızbaş [8] noted *Camarosporium kursanovii* Mekht. and *C. oreades* (Durieu & Mont.) Sacc. as causative agents of leaf spots on *Quercus macranthera*, and Taylor et al. [9] reported on *Camarosporium* species associated with leaf spots of *Protea cynaroides*, but all authors suggested that they were not economically important phytopathogens, except *C. pistaciae*.

Camarosporium is a large coelomycetous genus which was formerly recognised as an asexual state in Botryosphaeriales and Cucurbitariaceae. Molecular studies on the phylogenetic placement of the genus and species of *Camarosporium* have been carried out by Wijayawardene et al. [10, 11] and Crous & Groenwald [12] and showed that *Camarosporium* sensu stricto to Pleosporinae (Pleosporales).

During our collection of coelomycetes in Kırşehir Province of Turkey, we collected several *Camarosporium*-like species and carried out morphological studies. In this study we report on morphological data analyses of collected samples and seven taxa that show them to belong to new records.

New *Camarosporium* species registered in Boztepe district of Kırşehir province of Turkey. The Boztepe district situated in the central Kızılırmak section of the Anatolian Peninsula. The geographical coordinates of the studied area are 39°11ˈ–39°27ˈ N, 34°12ˈ –34°36ˈE and take place entirely in the Irano-Turanian phytogeographic region [13]. On the northern and north-eastern dry stream beds forest-steppe plant formations are common. Microclimate has been created by these areas for the Euro-Siberian and Mediterranean elements. According to the grid square system adopted by Davis [14] Boztepe district is located in the square B5.

2. MATERIAL AND METHODS

Specimens of the fungi were collected during periodical mycological excursions all in Boztepe district, Kırşehir Province, in 2012–2014. Microscopic studies were carried out on slides prepared in distilled water. Microphotographs were captured by Olympus BX 53 research microscope supplied with Olympus DP 22 digi-CAM (Japan) and Axio imager 2 equipped with Nomarski differential

interference contrast optics. Species were identified by consulting handbooks and other publications [3, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24]. The host plants were identified using "Flora of Turkey and East Aegean Islands" [14]. Taxa, families, and author citations are spelled according to Kirk & Ansell [25], and Index Fungorum [2]. All specimens are deposited in the Mycological Collection of the Ahi Evran University, Kırşehir (Arts and Sciences Faculty, Department of Biology).

3. RESULTS AND DISCUSSION

Taxonomy

Incertae Sedis

Anamorphic Pleosporales

Camarosporium astragalinum Sacc. & Trotter, Syll. fung. (Abellini) 22: 1078 (1913). Fig. 1.

Saprobic o n dead stems of *Astragalus asciocalyx*. **Sexual Morph:** Undetermined.

Asexual Morph: Conidiomata 450–500 µm diam. pycnidial, immersed, erumpent, solitary or in little groups, globose, subglobose, black, papillate. Conidia (12.5–) 15–17 × (5–)6–7 µm,

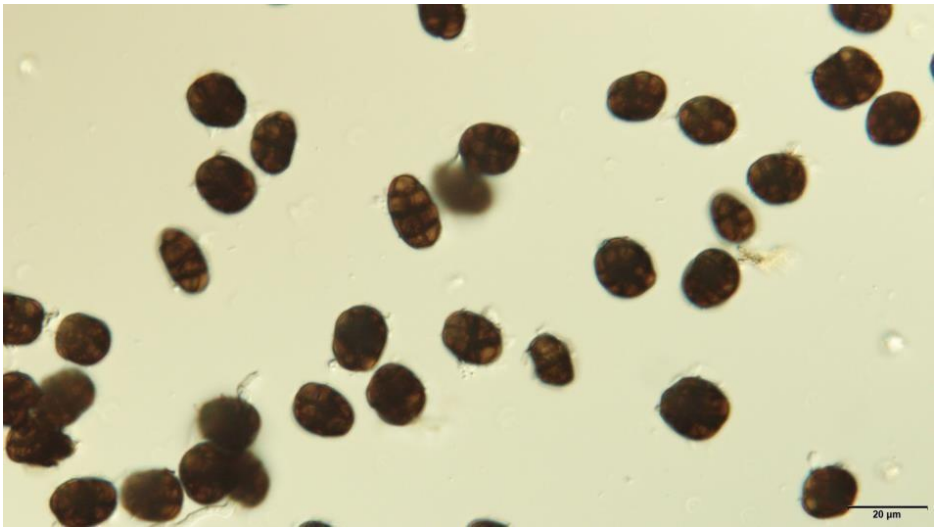

Fig 1. *Camarosporium astragalinum conidia.*

ellipsoid, muriform, with 2–3 transverse and 1–2 longitudinal septa, continuous or slightly constricted, initially hyaline, later becoming brown to dark-brown at maturity.

Known Distribution: Turkey (this paper), Hungary [19], Caucasus [26], and Turkmenistan [27, 28, 29]

Known Hosts–Fabaceae: *Astragalus asciocalyx* (this paper), *A. caucasicus* [26], *A. virgatus*

[19], *A.* sp. [29] and *A. unifoliolatus* [27, 28].

Material Examined:Turkey. Kirşehir: Boztepe, on dead stems of *Astragalus asciocalyx* ,1335 m a. s.l., 39° 13' 953''N, 34° 14' 967'' E, 27/ IV/2013, KE 35.

Comments: According to Saccardo and Trotter [19] conidiomata about 0.5 mm, conidia 14– 18 x 6 µm, with 3 transverse and 1–2 not complete longitudinally septa. The specimen KE 35 is morphologically similar to *C. astragalinum* [19]. However, the studied material has slightly wider and shorter conidia. In the literature, there are no records of *C. astragalinum* on *Astragalus asciocalyx*. So far, this species was found on three hosts of the *Astragalus* genus: *A. caucasicus* [26], *A. Virgatus* [19], *A.* sp. [29] and *A. unifoliolatus* [27, 28]. This is the first record *C. astragalinum* for Turkey and a new host, milkvetch *A. asciocalyx*.

Camarosporium cruciatum (Fuckel) Sacc. [**Bas**. *Coniothyrium cruciatum* Fuckel, *Jb. nassau. Ver. Naturk.*23-24: 173 (1870). **Homotypic syn:** *Camarosporium cruciatum* (Fuckel) Sacc., *Syll. fung.* (Abellini) 3: 464 (1884); *Camarosporulum cruciatum* (Fuckel) Tassi, *Bulletin Labor. Orto Bot. de R. Univ. Siena* 5: 65 (1902)]. Fig. 2. A-C.

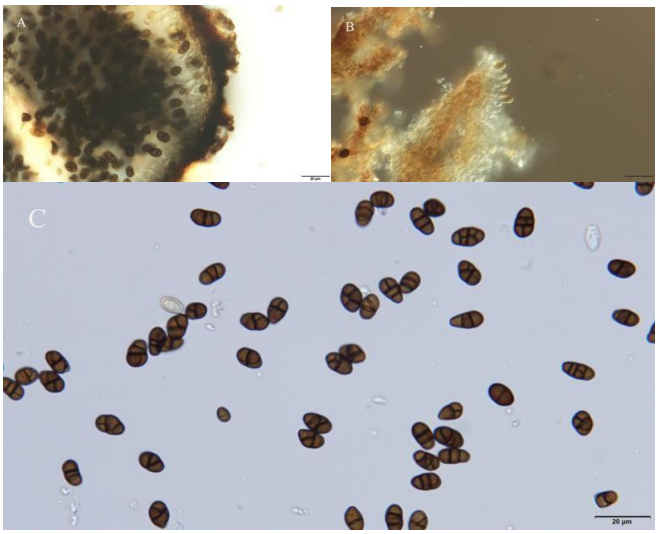

Fig 2. A–C. *Camarosporium cruciatum. A. Section of Pycnidium. B. Immatur conidia and conidiogen cells. C. Conidia.*

Saprobic on dead branches of *Ulmus minor*. **Sexual Morph:** Undetermined.

Asexual Morph: Conidiomata 250–320 µm diam., pycnidial, immersed, erumpent, gregarious, globose, black, with a round pore. Conidia 10–12(–13) × (5–)6–7 µm., ellipsoid, ovoid, mostly straight, occasionally slightly curved, with 1–3 transverse cruciate and single loculus longitudinally septa, slightly constricted, dark-brown.

Known Distribution: Turkey (this paper), Germany, Italy [15], Turkmenistan [30] and Ukraine [31].

Known Hosts–Betulaceae: *Alnus campestris* [15]; –**Moraceae:** *Morus alba* [30];– **Ulmaceae:** *Ulmus minor* (this paper); [31].

Material Examined: Turkey. Kirşehir: Boztepe, on dead branches of *Ulmus minor*, 1391 m a.s.l., 39° 12’ 519’’ N, 34° 12’ 965’’ E, 27/VII/2013, KE 114.

Comments: The collected material were identified as *C. cruciatum* according to Saccardo [15]. In his description, *C. cruciatum* has shorter conidia (6–10 µm diam.) with 1–4 transverse cruciate septa. This is the first record *C. cruciatum* for Turkey.

Camarosporium kirchneri Staritz, in Diedicke, *Krypt.-Fl. Brandenburg* (Leipzig) 9(4): 680 (1914).

Fig. 3. A–B. *Saprobic* on dead branches of *Prunus divaricata*.

Sexual Morph: Undetermined.

Asexual Morph: Conidiomata 350–400 µm diam., pycnidial, immersed, erumpent, scattered or gregarious, globose, dark-brown, with a round pore. Conidia 10–20 × 6–7,5 µm., oval, ovoid, oblong-ellipsoid, with 1–3 transverse and one not complete longitudinal septa, continuous or slightly constricted, brown.

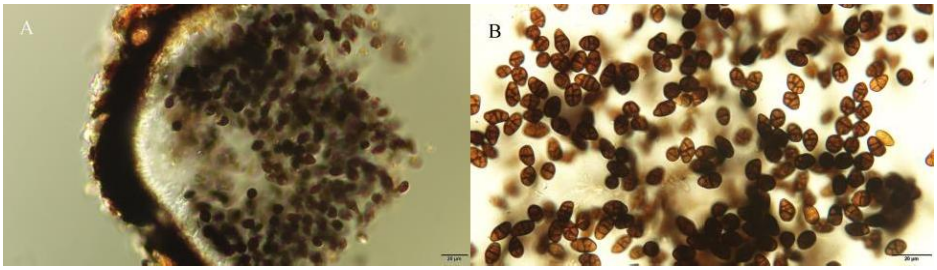

Fig 3. A–B. *Camarosporium kirchneri. A. Section of Pycnidium. B. Conidia.*

Known Distribution: Turkey (this paper), Germany [20], Kazakhstan [24], Turkmenistan [27], Moldavia [32] and Georgia [33].

Known Hosts–Rosaceae: *Prunus divaricata* (this paper; [33], *P. domestica* [20], *P. spinosa* [24], *Armeniaca vulgaris* [27] and *Cerasus avium, C. vulgaris, Amygdalus communis* [32].

Material Examined: Turkey. Kirşehir: Boztepe, on dead branches of *Prunus divaricata,*1326 m a.s.l., 39° 14’018’’ N, 34° 15’ 077’’ E, 27/IV/2013, KE 244.

Comments: According to Saccardo et al. [20] conidiomata up to 400 µm diam., conidia 13– 18 × 5–7 µm, 3-septate. Conidiomata of Kazakhstan samples on *Prunus spinosa* is 112–206 µm diam., conidia 8–17 × 5–7.5 µm, with 1–3 transverse and one longitudinal septa [24]. In Moldavia according to description of Popushoj [32] conidiomata 400–500 µm, conidia 14.5–17.5 × 6.5–9.8 µm, with 3–5 transverse and one longitudinal septa. The conidiomata and conidia of the specimen studied are larger than type species, Kazakhstan and Moldavia samples. This is the first record *C. kirchneri* for Turkey.

Camarosporium multiforme Schulzer & Sacc., *Hedwigia* 23: 110 (1884).Fig. 4. A–C.

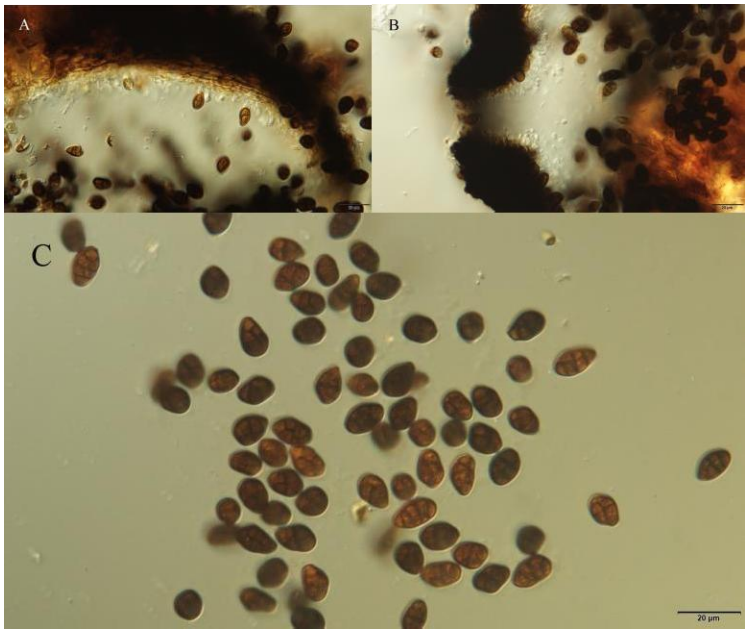

Fig 4. A–C. *Camarosporium multiforme. A. Section of Pycnidium, immature conidia and conidiogen cells. B. Section of pycnidial pore. C. Conidia*.

Saprobic on dead branches of *Crataegus aronia.* **Sexual Morph:** Undetermined.

Asexual Morph: Conidiomata 150–330 µm diam., pycnidial, immersed, then erumpent and almost superficial, scattered or densely gregarious, globoid, black, obtusely papillate, thick- walled. Conidia (11–)12–13(–17.5) × (7–)7.5–9 µm., ellipsoid, broadly ellipsoid, ovoid, pyriform, oblong, clavate, with 1–3 transverse cruciate and one complete or not complete cruciate longitudinal septa, continuous or slightly constricted, dark-brown.

Known Distribution: Turkey (this paper), Slovenia [15], Moldavia [32], Turkmenistan [30] and Ukraine [31].

Known Hosts –Rosaceae: *Crataegus aronia* (this paper), *Cydonia vulgaris* [15], *Pyrus communis* [32], *Chaenomeles japonica, Malus domestica* [30] and *Mespilus germanica* [31].

Material Examined: Turkey. Kirşehir: Boztepe, ondead branches of *Crataegus aronia,* 1337 m a.s.l., 39° 13’ 958’’ N, 34° 14’ 982’’ E, 02/XII/2012, KE 210; 1245 m a.s.l., 39° 14’036’’ N, 34° 14’ 707’’ E, 27/IV/2013, KE 235.

Comments: According to Saccardo [15] conidiomata 100–170 µm diam., conidia 9–12(–18) µm long, with 1–3 transverse and one not complete longitudinal septa. In description of Popushoj [32] conidiomata 200–400 µm, conidia 15–25 × 7–11 µm, with 3–5 transverse and 1–3 longitudinal septa. The specimen collected in Turkey has larger conidiomata and shorter conidia. In the literature [15, 30, 31, 32] documented this species associated with *Cydonia, Chaenomeles, Malus, Mespilus* and *Pyrus* species in Slovenia, Moldavia, Central Asia and Ukraine. There are no records of *C. multiforme* associated with *Crataegus* species. This is the first record of *C. multiphorme* for the Turkey and on a new host, the hawthorn *C. aronia.*

Camarosporium polymorphum (De Not.) Sacc., *Michelia* 1(no. 2): 208 (1878). [**Bas**. *Diplodia*

polymorpha De Not., *Micr. Ital.*, Dec. 4: fig.5 (1842)].Fig. 5. A–B.

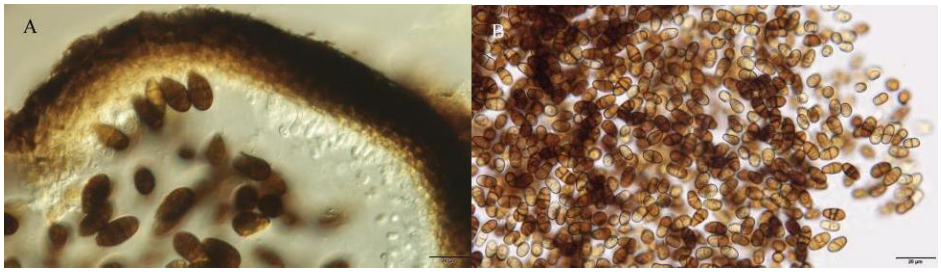

Fig 5. A–B. *Camarosporium polymorphum. A. Section of Pycnidium, immature conidia and conidiogen cells. B. Conidia.*

Saprobic on dead branches of *Lonicera etrusca*. **Sexual Morph:** Undetermined.

Asexual Morph: Conidiomata 180–250 µm diam., pycnidial, scattered, immersed, erumpent, globose, subglobose, papillate, dark-brown. Conidia 10–12.5 × 6–7.5(–8) µm, ellipsoid, ovoid, fusiform rounded at both ends, straight, occasionally slightly curved, muriform, with 1–3 transverse and one not complete longitudinal septa, continuous, shining brown.

Known Distribution: Turkey (this paper), Italy [15], Kazakhstan [24], Ukraine [31], Georgia [33], Uzbekistan [34], Kirgizia [35] and Pakistan [36].

Known Hosts – Caprifoliaceae: *Lonicera etrusca* (this paper), *L. xylostei* [15], *L. semenovii* [24], *L. tatarica* [35], *L.* sp. [36]; – **Oleaceae:** *Jasminum fruticans* [31];– **Rutaceae:** *Haplophyllum bungei*, *H.*sp. [34], *Phellodendron amurense* [33], *Ruta* sp. [15].

Material Examined: Turkey. Kirşehir: Boztepe, on dead branches of *Lonicera etrusca*,1342 m a.s.l., 39° 12’ 830’’ N, 34° 13’ 281’’ E, 04/XI/2012, KE 172.

Comments: According to Saccardo [15] conidia 10 x 8 µm with 3–4 transverse septa. In description of Byzova et al. [15] *C. polymorphum* has conidiomata 70–80 µm diam., conidia 7.5–9 × 6–7 µm, with 1–3 transverse and one not complete longitudinal septa. The Turkish samples differ from the diagnosis of type species in the larger sizes of conidia and smaller number of transverse septa and differ from Kazakhstan samples in larger size of conidiomata and conidia.This is the first record *C. polymorphum* for Turkey, and on a new host, the honeysuckle *Lonicera etrusca*.

Camarosporium ulmi Ellis & Dearn., Proc. of the Canad. Inst. 1897, p. 92. [**Homotypic syn:** *Camarosporulum ulmi* (Ellis & Dearn.) Tassi, *Bulletin Labor. Orto Bot. de R. Univ. Siena* 5: 66 (1902)].Fig. 6. A–C.

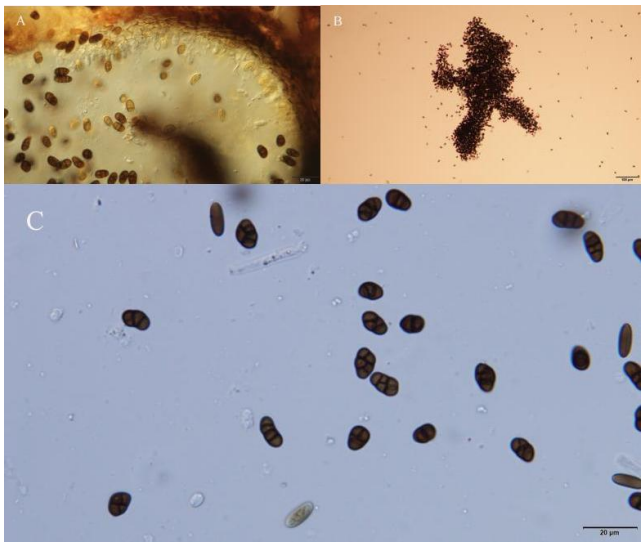

Fig 6. A–C. *Camarosporium ulmi. A. Section of Pycnidium, immature conidia and conidiogen cells. B. Mass of conidia as X. C. Conidia.*

Saprobic on dead branches of *Ulmus minor*. **Sexual morph:** Undetermined.

Asexual morph: Conidiomata 330–350 µm diam., pycnidial, gregarious, immersed, erumpent,

globose, depressed-globose, black, with circular central ostiole. Conidia 10–12(– 12,5) × 5–8(–9) µm, ellipsoid, ovoid, straight, or slightly curved, submuriform, with 1–4 transverse and one not complete longitudinal septa, slightly constricted, dark-brown.

Known Distribution: Turkey (this paper), England [17], Georgia [33] Kirghizia [35] and Canada [37].

Known Hosts – Ulmaceae: *Ulmus minor* (this paper), *U*. sp. [17, 33, 37] and *U. pinnato- ramosa* [35].

Material Examined: Turkey. Kirşehir: Boztepe, on dead branches of *Ulmus minor,*1391 m a.s.l., 39° 12’ 519’’ N, 34° 12’ 965’’ E, 27/VII/2013, KE 200.

Comments: According to Saccardo & Sydow [17] conidiomata about 330 µm diam., conidia 12–13 × 6–8 µm, 3-septate, and Mosolova [35] conidiomata of Kirgizian samples 256–358 µm., conidia 10–16 × 6–10 µm..The Turkish samples almost similar to the diagnosis of type species. However, the studied material has conidia with 1–3 transverse septa. Morever, conidia of our specimen is shorter then Kirghizian data. This is the first record *C. ulmi* for Turkey.

The genus *Camarosporium* are represented with six species: *C. astragalinum, C. cruciatum, C. kirchneri, C. multiforme, C. polymorphum,* and *C. ulmi*. These species identified as new records for the Anatolian Peninsula. All species are saprobic on dead stems, twigs or branches of trees and buches, and collected in forest ecosystems. Some morphological characteristics were also deviating from the original descriptions, but because of the lack of molecular data, a relatively conservative and broad species concept was applied instead of naming new species. Future molecular analyses might be helpful to clarify whether different hosts and minor morphological differences justify the separation of new taxa. Our findings demonstrate the importance of field collection and morphological analysis in different localities for fungal biodiversity inventories

A check of the current literature [7, 38, 39, 40, 41, 42, 43, 44, 45] revealed that 10 *Camarosporium* species have been reported from different localities in Turkey until the end of 2016. Nevertheless, a unified checklist of this genus does not exist. This study could be helpful in compiling the general checklist of *Camarosporium* species of Turkey. With the addition of new records the total number of Turkish *Camarosporium* species increased to 16. On the other hand, more than 500 species of *Camarosporium* have been recorded worldwide

4. CONCLUSION

Camarosporium astragalinum, C. cruciatum, C. kirchneri, C. multiforme, C. polymorphum and *C. ulmi* are first reports from the Anatolian Peninsula.

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