

Checklist of *Cladosporium* Species Reported from Turkey

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Abstract

Cladosporium species are common in nature (air, soil, etc.) and can be allergenic on human. The purpose of this study is to document the *Cladosporium* species isolated from Turkey with their substrates and/or habitat. This checklist reviews approximately 114 published findings and presents a list of *Cladosporium* species. According to the present publications, 33 *Cladosporium* species have been recorded with various substrates/habitats in Turkey. Among these species, *Cladosporium herbarum* and *Cladosporium cladosporioides* are the most common species reported from Turkey. The other species are *Cladosporium acaciicola*, *C. aecidiicola*, *C. apicale*, *C. asterinae*, *C. brassicae*, *C. britannicum*, *C. carpophilum*, *C. chlorocephalum*, *C. colocasiae*, *C. cucumerinum*, *C. elatum*, *C. fulvum*, *C. gallicola*, *C. macrocarpum*, *C. musae*, *C. nigrellum*, *C. obtectum*, *C. orchidaceraum*, *C. orchidis*, *C. ornithogali*, *C. oxysporum*, *C. ramotenellum*, *C. resinae*, *C. sinuosum*, *C. sphaerospermum*, *C. spongiosum*, *C. tenuissimum*, *C. trichoides*, *C. uredinicola* and *C. variabile*. The oldest literature is belonging to the year of 1952.

Keywords — air, checklist, *Cladosporium*, soil, Turkey

1 Introduction

The members of *Cladosporium* have a worldwide distribution and can be isolated from any organic matter, soil and food matrices. Besides, conidia of the genus are known as mostly found fungal particules in the air. Their relatively small spores have been adapted to reach far distances in atmosphere. This genus includes the species that pathogens of plants and causative agents to allergic or systemic infections in human respiratory system [1].

Members of *Cladosporium* genus produce hard and submerged, from olive green to gray green coloured colonies on the medium. Conidia are in found either branched or unbranched acropetal chains and subglobose, ellipsoid or fusiform in shape. The identification of these genus members is not so easy. Identification is based on morphological and colonial

characteristics, basically [1].

According to the records of “www.indexfungorum.org” website, it is reported that *Cladosporium* genus contains 796 species (May 06, 2016) that are found in 2 sections, 3 subgenus ve 1 fossil taxon. However, Bensch et al. [1] have reported that the accurate number of species for *Cladosporium* as 169, in their studies. Authors have evaluated the other taxa as “excluded species” and offer that they should be evaluated under the other genera.

Cladosporium genus was firstly characterized by Link in 1816. First described species is *C. herbarum*. While species number was 7 in Link (1824), it has raised to 110 in Saccardo (1886). According to Dugan et al. (2004) a total of 772 species have been reported as current, invalid, variety and other forms [1]. Since the systematics of the many of the names is problematic, there is a need to do more studies on this genus.

2 Methods

The main sources used in this study are *Web of Science* Database and other publications such as journals, books, proceedings etc. Current fungal names are controlled by www.indexfungorum.org and www.mycobank.org internet sites, related books and journals. Accepted names are bold & italics.

3 Results

List of Species, Substrates and/or Habitats, and Citation Numbers of Literature

Cladosporium Link, Mag. Gesell. naturf. Freunde, Berlin 7: 37 (1816) [1815]; Position in Classification: Cladosporiaceae, Capnodiales, Dothideomycetiadae, Dothideomycetes, Ascomycota, Fungi; Type Species: *Cladosporium herbarum* (Pers.) Link, in Willdenow (1816).

Cladosporium acaciicola M.B. Ellis, *More Dematiaceous Hyphomycetes* (Kew): 342 (1976). [**Air** – five primary schools in Edirne City [2], different primary schools in Edirne City [3], air of Çanakkale City [4], mosques in Edirne City [5].

Cladosporium aecidiicola Thüm., *Mycoth. Univ.*, cent. 4: no. 373 (1876). [**Air** - five primary schools in Edirne City [2], air of Çanakkale City [4], mosques in Edirne City [5], indoor and outdoor air of primary schools in Çorum City [6], child unit of public hospital in Edirne City [7].

Cladosporium apicale Berk. & Broome, *J. Linn. Soc., Bot.* 14(no. 74): 99 (1873) [1875]. [**Air** - mosques in Edirne City [5], indoor and outdoor air of primary schools in Çorum City [6], child unit of public hospital in Edirne City [7].

Cladosporium asterinae Deighton, *Mycol. Pap.* 118: 30 (1969). [**Current name: Parapericoniella asterinae** (Deighton) U. Braun, Heuchert & K. Schub., in Heuchert, Braun & Schubert, *Schlechtendalia* 13: 59 (2005)] [**Air** - five primary schools in Edirne City [2], different primary schools in Edirne City [3].

Cladosporium brassicae (Ellis & Barthol.) M.B. Ellis, *More Dematiaceous Hyphomycetes* (Kew): 340 (1976). [**Air** - indoor and outdoor air of primary schools in Çorum City [6].

Cladosporium britannicum M.B. Ellis, *More Dematiaceous Hyphomycetes* (Kew): 328 (1976). [**Current name: Fusicladium britannicum** (M.B. Ellis) U. Braun & K. Schub., *Mycotaxon* 103: 211 (2008)]. [**Air** – mosques in Edirne City [5].

Cladosporium carpophilum Thüm., *Öst. bot. Z.* 27: 12 (1877). [**Current name: Venturia carpophila** E.E. Fisher, *Trans. Br. mycol. Soc.* 44(3): 339 (1961)]. [**Air** – vegetable plants in Edirne City [8]; **Soil** – agricultural areas in Eskişehir City [9].

Cladosporium chlorocephalum (Fresen.) E.W. Mason & M.B. Ellis, *Mycol. Pap.* 56: 123 (1953). [**Current name: Graphiopsis chlorocephala** Trail, *Scott. Natural.*, N.S. 4 ('10'): 75 (1889)]. [**Air** – five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5], child unit of public hospital in Edirne City [7], indoor air of Trakya University hospital [10], child care centers in Edirne City [11], oncology unit of Faculty of Medicine of Trakya University [12], dental unit waterlines and air in Istanbul City [13]; **Other** – fungi presented amilolytic activity [14].

Cladosporium cladosporioides (Fresen.) G.A. de Vries, *Contrib. Knowledge of the Genus Cladosporium Link ex Fries:* 57 (1952). [**Air** – five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5], indoor and outdoor air of primary schools in Çorum City [6], child unit of public hospital in Edirne City [7], child care centers in Edirne City [11], oncology unit of Faculty of Medicine of Trakya University [12], dental unit waterlines and air in Istanbul City [13], food factories [15], indoor air of Trakya University hospital [10], Terkos Lake in İstanbul City [16], Belgrad forest in İstanbul City [17], indoor and outdoor air in İstanbul City [18], Eskişehir air [19], outdoor in Erzurum City [20], indoor in Afyon City [21], Sabiha Gökçen Anatolian vocational high school [22], Afyonkarahisar air [23], indoor air of houses in Erzurum City [24], Gazi University Faculty of Medicine [25], outdoor air in Manisa City [26], indoor and outdoor air in Tekirdağ City [27], outdoor air in Elazığ City [28], indoor and outdoor air in Selimiye library [29], air and soil of Hamitabat Thermic Power Plant [30], nursing home in Edirne City [31], two hospitals in İstanbul City [32], poultry facility [33], sea-

sonal distribution of fungi in two hospitals in İstanbul City [34], child care center in Balıkesir City [35], air of refrigerator [36], wood factory [107]; **Soil** – agricultural areas in Eskişehir City [9], meat facility in Erzurum City [37], forest soil in Sarıkamış [38], North-East Anatolia soil [39], agricultural mycobiota [40], soil of North-East Anatolia [41], Florya Atatürk forest soil [42], burnt and unburnt forest soil [43], Harran plain [44], cement facility in Gaziantep City [45], two different soil type in Bartın City [46], soil in Erzurum City [47], mountain soil in Kilis City [48], soil in Kilis City [49]; **Other** – fungi presented amilolytic activity [14], strawberry root [50], food samples [51], tomatoes and tomato paste [52], fungi on house dust in İstanbul City [53], tree bark [54], biological control [55], onion seeds [56], cerebrospinal fluid [57], samples of mycoses laboratories [58], black spots on wheat samples [59], sick building syndrome reports [60], dry fig samples [61], wheat and feed samples [62], marble areas in historical places [63], moldy cheese [64], sausage samples [65], merino sheeps [66], surface of rafignatoid acares [67], potato tuber samples [68], pocket phones [69], automated teller machines and bank cards in Marmaris [111].

Cladosporium colocasiae Sawada, *Journal of the Natural History Society Taiwan* 25: 125 (1916). [**Air** - mosques in Edirne City [5], indoor and outdoor air in Selimiye library [29]; **Soil** – agricultural areas in Eskişehir City [9].

Cladosporium cucumerinum Ellis & Arthur, *Bull. Indiana Agric. Stat.* 19: 9 (1889). [**Air** - five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5], child unit of public hospital in Edirne City [7], indoor air of Trakya University hospital [10], child care centers in Edirne City [11], oncology unit of Faculty of Medicine of Trakya University [12], dental unit waterlines and air in Istanbul City [13], Terkos Lake in İstanbul City [16], indoor and outdoor air in Selimiye library [29], nursing home in Edirne City [31], poultry facility [33].

Cladosporium elatum (Harz) Nannf., in Melin & Nannfeldt, *Svensk Skogsvårdsförening Tidskr.* 3-4: 422 (1934). [**Current name: Ochrocladosporium elatum** (Harz) Crous & U. Braun, in Crous, Braun, Schubert & Groenewald, *Stud. Mycol.* 58: 46 (2007)]. [**Air** - five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5],

child unit of public hospital in Edirne City [7], child care centers in Edirne City [11], oncology unit of Faculty of Medicine of Trakya University [12], dental unit waterlines and air in Istanbul City [13], air and soil of Hamitabat Thermic Power Plant [30], nursing home in Edirne City [31], poultry facility [33]; **Soil** - cement facility in Gaziantep City [45]; **Other** – marble areas in historical places [63].

Cladosporium epiphyllum (Pers.) Nees, *Syst. Pilze (Würzburg)*: 67 (1816) [1816–17]. [**Soil** – soil in Izmir City [109].

Cladosporium fulvum Cooke, *Grevillea* 6(no. 40): 139 (1878). [**Current name: Passalora fulva** (Cooke) U. Braun & Crous, in Crous & Braun, *CBS Diversity Ser.* (Utrecht) 1: 453 (2003)]. [**Soil** – tomatoes fields [70], vegetables fields [71, 72, 73].

Cladosporium herbarum (Pers.) Link, in Willdenow, *Mag. Gesell. naturf. Freunde, Berlin* 8: 37 (1816) [1815]. [**Air** – five primary schools in Edirne City [2], different primary schools in Edirne City [3], air of Çanakkale City [4], mosques in Edirne City [5], indoor and outdoor air of primary schools in Çorum City [6], child unit of public hospital in Edirne City [7], vegetable plants in Edirne City [8], indoor air of Trakya University hospital [10], child care centers in Edirne City [11], food factories [15], Terkos Lake in İstanbul City [16], Belgrad forest in İstanbul City [17], indoor and outdoor air in İstanbul City [18], outdoor in Erzurum City [20], indoor in Afyon City [21], Afyonkarahisar air [23], indoor air of houses in Erzurum City [24], outdoor air in Manisa City [26], indoor and outdoor air in Tekirdağ City [27], outdoor air in Elazığ City [28], air and soil of Hamitabat Thermic Power Plant [30], nursing home in Edirne City [31], two hospitals in İstanbul City [32], seasonal distribution of fungi in two hospitals in İstanbul City [34], child care center in Balıkesir City [35], air of Ankara City [74], air of Edirne City [75], indoor air in Manisa City [76], primary schools in İzmir City [77], psycotrophic fungi in refrigerator [78], air of Adana City [79]; **Soil** – agricultural areas in Eskişehir City [9], meat facility in Erzurum City [37], forest soil in Sarıkamış [38], agricultural mycobiota [40], soil of North-East Anatolia [41], burnt and unburnt forest soil [43], Harran plain [44], cement facility in Gaziantep City [45], soil in Kilis City [49], mountain of Eğerli and Trabzon-Hopa coastline [80], cereals

fields in Eskişehir City [81], wheat fields in Kırka, Eskişehir City [82], soil of Belgrad forest [83], wheat fields in Eskişehir City [84], soil polluted with lead in Eskişehir City [85], forest soil of North Trakya region [86], soil polluted with industrial wastewater in Aydın, İzmir and Manisa [87], agricultural soil in Manisa City [110]; **Other** – fungi presented amilolytic activity [14], food samples [51], tomatoes and tomato paste [52], fungi on house dust in İstanbul City [53], wheat and feed [62], moldy cheese [64], pocket phones [69], plant pathogens in Turkey [88], bean seeds [89], microfungi of potatoes and onions [90], types of cheeses [91], surface of grape shapes fruits [92], dry bean seeds in Eskişehir City [93], seeds of coniferous [94], dry bean seeds [95], food samples [96], endophytes of *Laurus nobilis* [97], nasal lavage [98], isolated from chronic rhinosinusitis patients [99], traditional cheeses [100], microfungi in wheat ecosystem [101], microfungi in forest ecosystems in Turkey [102], apples in warehoused in Izmir [108], automated teller machines and bank cards in Marmaris [111].

Cladosporium gallicola B. Sutton, *Mycol. Pap.* 132: 37 (1973). [**Air** - indoor and outdoor air of primary schools in Çorum City [6].

Cladosporium macrocarpum Preuss, in Sturm, *Deutschl. Krypt.-Fl.* (Leipzig) 3(6): 27 (1848). [**Current name: Davidiella macrocarpa** Crous, K. Schub. & U. Braun, in Schubert, Groenewald, Braun, Dijksterhuis, Starink, Hill, Zalar, de Hoog & Crous, *Stud. Mycol.* 58: 129 (2007)]. [**Air** - five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5], child unit of public hospital in Edirne City [7], indoor air of Trakya University hospital [10], child care centers in Edirne City [11], air and soil of Hamitabat Thermic Power Plant [30], nursing home in Edirne City [31], air of refrigerator [36], psycotrophic fungi in refrigerator [78]; **Soil** – agricultural areas in Eskişehir City [9], North-East Anatolia soil [39], agricultural mycobiota [40], soil of North-East Anatolia [41], mountain of Eđerli and Trabzon-Hopa coastline [80]; **Other** - food samples [51], tomatoes and tomato paste [52], fungi on house dust in İstanbul City [53], sick building syndrome reports [60], wheat and feed samples [62].

Cladosporium musae E.W. Mason, in Martyn, *Mycol. Pap.* 13: 2 (1945). [**Current name: Metulocladosporiella**

musae (E.W. Mason) Crous, Schroers, J.Z. Groenew., U. Braun & K. Schub., *Mycol. Res.* 110 (3): 269 (2006)]. [**Air** - oncology unit of Faculty of Medicine of Trakya University [12].

Cladosporium nigrellum Ellis & Everh., *Proc. Acad. nat. Sci. Philad.* 45: 463 (1894) [1893]. [**Air** – indoor and outdoor air in Selimiye library [29].

Cladosporium obtectum Rabenh., *Grevillea* 17(no. 83): 66 (1889). [**Air** - indoor and outdoor air of primary schools in Çorum City [6].

Cladosporium orchidaceraum Cooke & Masee, *Grevillea* 16 (no. 79): 80 (1888). [**Air** – indoor air of Trakya University hospital [10].

Cladosporium orchidis E.A. Ellis & M.B. Ellis, in Ellis, *Mycol. Pap.* 131: 17 (1972). [**Air** - mosques in Edirne City [5], indoor and outdoor air of primary schools in Çorum City [6]; **Soil** – forest soil in Sarıkamış [38], North-East Anatolia soil [39, 41]; **Other** – surface of stone monuments [104].

Cladosporium ornithogali (Klotzsch) G.A. de Vries, *Contrib. Knowledge of the Genus Cladosporium Link ex Fries:* 491 (1952). [**Current name: Heterosporium ornithogali** Klotzsch, in Cooke, *Grevillea* 5(no. 35): 123 (1877)]. [**Air** - indoor and outdoor air of primary schools in Çorum City [6].

Cladosporium oxysporum Berk. & M.A. Curtis, in Berkeley, *J. Linn. Soc., Bot.* 10(no. 46): 362 (1868) [1869]. [**Air**- five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5], indoor and outdoor air of primary schools in Çorum City [6], child unit of public hospital in Edirne City [7], food factories [15], Afyonkarahisar air [23], indoor air of houses in Erzurum City [24], outdoor air in Manisa City [26], indoor and outdoor air in Tekirdağ City [27], outdoor air in Elazığ City [28], indoor and outdoor air in Selimiye library [29], nursing home in Edirne City [31], two hospitals in İstanbul City [32], child care center in Balıkesir City [35], air of Edirne City [75], indoor air in Manisa City [76], primary schools in İzmir City [77], air of Adana City [79]; **Soil** - forest soil in Sarıkamış [38], North-East Anatolia soil [39], soil of North-East Anatolia [41], burnt and unburnt forest soil [43], cement facility in Gaziantep City [45], two different soil type in Bartın City [46].

Cladosporium ramotenellum K. Schub., Zalar, Crous & U. Braun, in Schubert, Groenewald, Braun, Dijksterhuis, Starink, Hill, Zalar, de Hoog & Crous, *Stud. Mycol.* 58: 137 (2007). [**Air** – nursing home in Edirne City [31], poultry facility [33].

Cladosporium resinae (Lindau) G.A. de Vries, *Antonie van Leeuwenhoek* 21: 167 (1955). [**Current name:** *Amorphotheca resinae* Parbery, *Aust. J. Bot.* 17: 340 (1969)]. [**Soil** – agricultural mycobiota [40].

Cladosporium sinuosum K. Schub., C.F. Hill, Crous & U. Braun, in Schubert, Groenewald, Braun, Dijksterhuis, Starink, Hill, Zalar, de Hoog & Crous, *Stud. Mycol.* 58: 141 (2007). [**Air** – nursing home in Edirne City [31].

Cladosporium sphaerospermum Penz., *Michelia* 2(no. 8): 473 (1882). [**Air** - five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5], child unit of public hospital in Edirne City [7], child care centers in Edirne City [11], food factories [15], Terkos Lake in İstanbul City [16], indoor and outdoor air in İstanbul City [18], outdoor air in Manisa City [26], indoor and outdoor air in Tekirdağ City [27], outdoor air in Elazığ City [28], indoor and outdoor air in Selimiye library [29], air and soil of Hamitabat Thermic Power Plant [30], nursing home in Edirne City [31], seasonal distribution of fungi in two hospitals in İstanbul City [34], child care center in Balıkesir City [35], air of refrigerator [36], primary schools in İzmir City [77]; **Soil** - forest soil in Sarıkamış [38], agricultural mycobiota [40], soil of North-East Anatolia [41], burnt and unburnt forest soil [43], Harran plain [44], two different soil type in Bartın City [46], mountain of Eđerli and Trabzon-Hopa coastline [80], garden soil in Lapseki [105], tomatoes greenhouse [106]; **Other** - fungi presented amilolytic activity [14], food samples [51], tomatoes and tomato paste [52], fungi on house dust in İstanbul City [53], sick building syndrome reports [60], marble areas in historical places [63], pocket phones [69], automated teller machines and bank cards in Marmaris [111].

Cladosporium spongiosum Berk. & M.A. Curtis, in Berkeley, *J. Linn. Soc., Bot.* 10(no. 46): 362 (1868) [1869]. [**Air** – mosques in Edirne City [5], child unit of public hospital in Edirne City [7], indoor air of Trakya University hospital [10], dental unit waterlines and air in İstanbul City [13], nursing home in Edirne City [31],

poultry facility [33].

Cladosporium tenuissimum Cooke, *Grevillea* 6(no. 40): 140 (1878). [**Air** - five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5], indoor and outdoor air of primary schools in Çorum City [6], child unit of public hospital in Edirne City [7], child care centers in Edirne City [11], oncology unit of Faculty of Medicine of Trakya University [12], dental unit waterlines and air in İstanbul City [13], indoor and outdoor air in Selimiye library [29], nursing home in Edirne City [31]; **Other** – isolated from pocket phones [69].

Cladosporium trichoides C.W. Emmons, in Binford, Thompson & Gorham, *Am. J. clin. Path.* 22: 541 (1952). [**Current name:** *Cladophialophora bantiana* (Sacc.) de Hoog, Kwon-Chung & McGinnis, in de Hoog, Guého, Masclaux, Gerrits van den Ende, Kwon-Chung & ?, *J. Med. Vet. Mycol.* 33(5): 343 (1995)]. [**Other** – brain abscess [103].

Cladosporium uredinicola Speg., *Anal. Mus. nac. Hist. nat. B. Aires* 23: 122 (1912). [**Air** – five primary schools in Edirne City [2], different primary schools in Edirne City [3], mosques in Edirne City [5], indoor and outdoor air in Selimiye library [29], poultry facility [33].

Cladosporium variabile (Cooke) G.A. de Vries, *Contrib. Knowledge of the Genus Cladosporium Link ex Fries:* 85 (1952). [**Current name:** *Davidiella variabile* Crous, K. Schub. & U. Braun, in Schubert, Groenewald, Braun, Dijksterhuis, Starink, Hill, Zalar, de Hoog & Crous, *Stud. Mycol.* 58: 152 (2007)]. [**Air** - five primary schools in Edirne City [2], different primary schools in Edirne City [3], indoor and outdoor air of primary schools in Çorum City [6], child unit of public hospital in Edirne City [7], indoor air of Trakya University hospital [10], child care centers in Edirne City [11], oncology unit of Faculty of Medicine of Trakya University [12], Terkos Lake in İstanbul City [16], indoor and outdoor air in Selimiye library [29], air and soil of Hamitabat Thermic Power Plant [30], nursing home in Edirne City [31], poultry facility [33].

4 Conclusions

If we consider publications addressed Turkey, *Cladosporium herbarum* and *C. cladosporioides* species are the most common species reported from Turkey. According to the published reports addressed Turkey, there are 33 *Cladosporium* species reported from Turkey. When we consider more than 169 *Cladosporium* species, number of 33 species are very less for reported from Turkey. There are a few checklists such as Asan (112-114) about common mould genera reported from Turkey; so it should be study checklist of the other genera. Our studies will contribution to checklist studies in Turkey.

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