THE GENUS SARCOSCYPHA IN CROATIA.
ECOLOGICAL AND DISTRIBUTION PATTERNS

Neven MATOČEC ¹ & Ivana KUŠAN ²
¹ Laboratory of Biocenotical Research
Rudjer Bošković Institute
Bijenička 54, 10 000 Zagreb, Croatia
² Croatian Mycological Society
Sveti Duh 63/1, 10 000 Zagreb, Croatia

Abstract
All species of the Sarcoscypha coccinea agg. (viz. S. austriaca, S. coccinea, S. jurana and S. macaronesica) hitherto known to occur in Europe are listed, mapped and ecologically analyzed through records so far collected in Croatia. The ecological niches and substrate preferences are discussed and compared with results from other European special studies. Apothecial development and conidial behaviour of selected fructifications of S. austriaca is monitored from 1990 to 1992. Sarcoscypha austriaca and S. coccinea were already known for Croatia, while S. macaronesica and S. jurana are recorded as new for Croatia.

Key words: Ascomycota, Pezizales, Sarcoscypha, S. austriaca, S. coccinea, S. jurana, S. macaronesica. – biogeography, ecology, inventory and mapping. – mycobiota of Croatia.

Introduction

Both the occurrence and high frequency of the hibernal-vernal genus Sarcoscypha in Croatia is long well-known, with the oldest known record published by SCHULZER (1857) as Peziza coccinea for which author states «winterlich, vom Dezember, seltner schon Ende Oktober bis März» and «nirgend selten». As a substrate he quotes rotten branches of Quercus sp., Prunus spinosa and P. domestica. The genus was later also recorded by VOUK & PEVALEK (1915), TORTIĆ (1966, 1968), FOCHT (1979) with all records determined as S. coccinea and TORTIĆ (1989) as S. coccinea s. lat. Subsequently, FOCHT (1986) briefly presented three species (S. austriaca, S. coccinea and S. macaronesica) with some general notes about their occurrence and substrate preferences for area of former Yugoslavia but without
any specifications on material or localities. Presently, it is not possible to decide on the species identity in all of these older records unless exsiccata were saved for microscopical revision. No special study of the genus in Croatia has been undertaken since Baral (1984) showed reliable criteria for species delimitation. In his study he included seven exsiccata from Croatia collected in 60's and 70's of the 20th century by Milica Tortić and colleagues and he found that they include two species – S. austriaca and S. coccinea s. str. Thus, following a short article series that summarize the genus Scutellinia in Croatia (Matočec, Antonić, Mrvoš 1995; Matočec 1998, 2000), we treat all known material of the genus Sarcoscypha in the national scale, which is presented in a similar way. In this paper we do not provide species descriptions as well as the concepts of their delimitation since they are already well described and delimited (Baral 1984).

**Material and Methods**

Fresh material collected during our long term research of discocymetous fungi was treated in the living state whenever possible, applying techniques described in Baral (1992). Our remaining collections and the older dried specimens were taken into analysis subsequently. The preparation techniques follow earlier paper (Matočec, Antonić & Mrvoš, 1995) except for the exsiccata cutting. Hand sections were prepared by vertical-median cutting of dried apothecia with the razor blade. Spores from the dried specimens were observed and measured rather in tap water than in KOH solution as the latter medium causes heavy spore shape distortion and wall layer loosening. Over 200 specimens collected from 1964 to the present date produced four closely related species that could be identified at best when in living state (cf. Baral 1984). All bioclimatic belts in Croatia were covered with this research, ranging from continental lowland, montane and subalpine to the Mediterranean area. Few comparative collections from neighbouring regions are also included. In regional landscape units delimitation we follow Radović (2000) with minor modifications. In the species concept we follow Baral (1984). MTB grid with basic grid level is used for mapping. All exsiccata and recorded data are deposited in the CNF (Croatian National Fungarium). In order to reduce space, both the layout and citation of examined material data follow the mode presented in earlier paper (Matočec, Krisai-Greilhuber & Scheuer, 2005).

**Localities visited**

1. **Babin kuk area, Lapad peninsula, Dubrovnik** (23.3.1981) - Southern Dalmatia, MTB 3374, 40 m s. m.; tall evergreen forest with Quercus ilex, Laurus nobilis, Myrtus communis etc.

2. **Babin zub peak (452)-Sopotski slap, Mt. Medvednica** (5.1.1998) - North-western Croatia, MTB 0161, 360 m s. m.; riparian forest of Alnus glutinosa and Salix spp.

3. **Bedenik forest (Bjelovar)** (25.11.1987) – Bilogorsko-Moslavačka region, MTB 0066, 130 m s. m.; broadleaved forest.

4. **Berencebarati (Hont)** (1.4.1996; 4.4.1996) – Hungary, lowland oak forest with common hornbeam with planted Robinia pseudoacacia.

5. **Bliznec brook below Varoško rebro area, Mt. Medvednica** (30.11.1982) – North-western Croatia, MTB 0161, 290 m s. m.; riparian forest of Alnus glutinosa and Salix spp.

7. Braslovje (Rude), Samoborsko gorje range (16.2.1997) - Žumberak, MTB 0259, 400 m s. m.; mediterranean deciduous shrub Ostrya carpinifolia, Fraxinus ornus, Quercus dalechampii and with Erica carnea.

8. Bregana river near Gabrovica, Žumberak range (8.2.1992) - Žumberak, MTB 0160, 200 m s. m.; riparian forest of Alnus glutinosa and Salix spp.


10. Brezakovec (Kumrovec) (24.2.2002; 23. 4.2005) - North-western Croatia, MTB 9959, 280 m s. m.; anthropogenous open habitat with planted Picea abies, Robinia pseudoacacia and Sambucus nigra shrubs.

11. Brezine forest (Križevci) (12.3.1988; 18.3.1988; 12.4.1993) – Bilogorsko-Moslavačka region, MTB 9965, 150 m s. m.; deciduous forest of Quercus petraea, Carpinus betulus and Fagus sylvatica with some Robinia pseudoacacia on its fringes.

12. Brezine forest-Potočak brook (Križevci) (7.2.1988) – Bilogorsko-Moslavačka region, MTB 9965, 150 m s. m.; riparian forest of Alnus glutinosa, Salix spp. and Populus spp.

13. Bukovača forest near Končanica fishery (Daruvar) (4.4.1994) – Bilogorsko-Moslavačka region, MTB 0368, 150 m s. m.; Salix alba stand.

14. Bundek lake, Zagreb (1.4. 2001) – Posavina lowland, MTB 0261, 120 m s. m.; Pinus nigra and P. sylvestris plantations with Robinia pseudoacacia and Sambucus nigra shrubs.

15. Cer area, Mt. Medvednica (24.3.2002) – North-western Croatia, MTB 0062, 600 m s. m.; deciduous forest of Fagus sylvatica.

16. Daruvar (30.3.1966) – Bilogorsko-Moslavačka region, MTB 0469, 160 m s. m.

17. Dolje, Zagreb (22.2. 1992) – North-western Croatia, MTB 0161, 250 m s. m.; anthropogenous shrub habitat of Robinia pseudoacacia and Sambucus nigra.

18. Donja Dobra (Brod Moravice) (4.4. 1992) – Gorski kotar, MTB 0555, 450 m s. m.; riparian forest of Alnus glutinosa, Salix spp. with Corylus avellana.

19. Draše (Dubravica near Zaprešić) (3.4.1988) – North-western Croatia, MTB 9960, 170 m s. m.; deciduous forest of Quercus robur and Carpinus betulus, with inclusions of Robinia pseudoacacia.

20. Družanica area, Mt. Medvednica (23.1.1993) – North-western Croatia, MTB 0161, 430 m s. m.; degraded deciduous forest of Carpinus betulus and Corylus avellana with heavy inclusions of Robinia pseudoacacia and Sambucus nigra.

21. Dubočanka brook-middle part, Mt. Papuk (Velika) (31.3.2003) – Central Slavonia, MTB 0572, 350 m s. m.; montane broadleaved forest.

22. Glavica area, Mt. Medvednica (31.3.1996) – North-western Croatia, MTB 0161, 440 m s. m.; degraded deciduous forest of Quercus petraea, Fagus sylvatica, Carpinus betulus with inclusions of Robinia pseudoacacia and Sambucus nigra.

23. Gomirje (7.4.2000) – Gorski kotar, MTB 0656, 350 m s. m.; deciduous forest of Alnus glutinosa, Carpinus betulus with Sambucus nigra.

24. Gorica forest (Gomirje) (17.11.1996; 5.4.1997; 31.10.1999) – Gorski kotar, MTB
0656, 430 m s. m.; mixed forest of *Abies alba* and *Fagus sylvatica* with *Picea abies*.

25. Gornja Bistra-Kraljev Vrh (1.4. 2004) – North-western Croatia, MTB 0061, 250 m s. m.; deciduous forest of *Quercus petraea*, *Carpinus betulus* and *Fagus sylvatica* strongly degraded throughout, thus with high portions of *Corylus avellana*, *Robinia pseudoacacia*, *Sambucus nigra* and *Pinus sylvestris*.

26. Gornji Štenjevec-Veternica cave, Mt. Medvednica (17.3.1991; 23.1.1993; 3.2.2001; 9.3.2002) - North-western Croatia, MTB 0161, 220-300 m s. m., degraded deciduous forest of *Carpinus betulus*, *Corylus avellana*, *Cornus sanguinea*, interspersed with *Robinia pseudoacacia* and *Sambucus nigra*.

27. Gorsćica area, Mt. Medvednica (19.4.1992) – North-western Croatia, MTB 0062, 700 m s. m.

28. Gračani, Zagreb (30. 11. 1982) - North-western Croatia, MTB 0161, 240-290 m s. m.; orchards and grasslands with *Prunus domestica*, *Cornus sanguinea* and *Robinia pseudoacacia*.

29. Gradac Požeški (Požega) (31.3.2002) - Central Slavonia, MTB 0672, 130 m s. m., deciduous forest of *Quercus robur*, *Ulmus minor*, *Carpinus betulus*, *Corylus avellana* and *Acer campestre*.

30. Gradina area-Vincek (Repaš) (10.1.1999) – Podravina lowland, MTB 9868, 120 m s. m., flood forest of *Quercus robur* and *Fraxinus angustifolia* with *Ulmus minor*.


33. Gvozdeni-Topli brook (Ljubošina, Gomirje) (22.2.1997) - Gorski kotar, MTB 0657, 410 m s. m.; deciduous forest of *Fagus sylvatica* and *Corylus avellana*.

34. Idrija area (2.4.1967) - Slovenia (type locality of *Peziza cocinea*).

35. Ilovica area (Ravna Gora), Mt. Velika Kapela (2.5. 2004) – Gorski kotar, MTB 0655, 820 m s. m.; mixed forest of *Abies alba*, *Fagus sylvatica*, *Picea abies* and *Acer pseudoplatanus*.

36. Izimje (Jastrebarsko) (18.3.2001; 1.4.2001) – Posavina lowland, MTB 0359, 140 m s. m.; deciduous forest of *Quercus robur* partly changed into *Picea abies* and *Larix decidua* plantations interspersed with *Robinia pseudoacacia* and *Sambucus nigra*.

37. Jagerov kut area (Ždala) (11.1.1999) – Podravina lowland, MTB 9869, 110 m s. m.; flood forest of *Fraxinus angustifolia*, *Frangula alnus*, *Ulmus minor*, *Alnus incana*, *A. glutinosa* with *Sambucus nigra*.

38. Jambrišakovo vrelo spring (Ponikve area), Mt. Medvednica (31.1.1996; 9.3.1997) – North-western Croatia, MTB 0161, 480 m s. m.; riparian forest of *Alnus glutinosa*, *Salix* spp. with inclusions of *Robinia pseudoacacia*.

39. Jambrišakovo vrelo spring-Podljelka area, Mt. Medvednica (21.4.1996) - North-western Croatia, MTB 0161, 510 m s. m.; forest of *Alnus glutinosa*, *Carpinus betulus* with inclusions of *Robinia pseudoacacia*.

40. Jarun lake-Sava river, Zagreb (12.3.1979) – Posavina lowland, MTB 0261, 120 m s. m.; tall riparian forest of *Populus alba* and *Salix* spp.

41. Javorek brook-Cerinski vir fall, Samoborsko gorje range (7.1.1998) - Žumberak, MTB 0259, 340 m s. m.; *Alnus glutinosa* streamside in the forest of *Fagus sylvatica*, *Carpinus*
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42. Jazavica area (Grubišno Polje) (21.1.1995) – Bilogorsko-Moslavačka region, MTB 0269, 160 m s. m., remnants of riparian *Alnus glutinosa* stand with many *Robinia pseudoacacia* and *Sambucus nigra*.

43. Jelenovac park, Zagreb (3.2.1992; 27.3.2007) – North-western Croatia, MTB 0161, 150-180 m s. m., deciduous forest of *Quercus petraea*, *Carpinus betulus*, *Fagus sylvatica*, *Prunus avium* interspersed with *Robinia pseudoacacia* and *Sambucus nigra*.

44. Ježdovec (Zagreb) (1.4.1990) – Posavina lowland, MTB 0261, 120 m s. m.; *Pinus plantation* with extensive inclusions of *Robinia pseudoacacia*.

45. Kalnička greda area, Mt. Kalnik (6.12.1987) – North-western Croatia, MTB 9865, 480 m s. m.; deciduous forest of *Fagus sylvatica*, *Quercus petraea* and *Carpinus betulus*.

46. Kalnik mountain hut, Mt. Kalnik (5.4.1987) – North-western Croatia, MTB 9864, 480 m s. m.; deciduous forest of *Quercus petraea* and *Carpinus betulus*.

47. Kamačnik brook-Kamačnik house (Vrbovsko) (1.11.1996; 16.11.1996) – Gorski kotar, MTB 0656, 400-410 m s. m.; deciduous forest of *Fagus sylvatica*, *Acer pseudoplatanus*, *Carpinus betulus* and *Corylus avellana*.

48. Kamanje-Kupa river (Ozalj) (16.2.1997) – Plateau of Kordun and Pokuplje, MTB 0358, 160 m s. m.; forest remnants of *Carpinus betulus* and *Corylus avellana* with *Robinia pseudoacacia* plantation.

49. Kamenica brook-Galezova Draža (Vivodina) (16.2.1997) – Žumberak, MTB 0358, 150-160 m s. m.; riparian forest of *Alnus glutinosa* and *Salix* sp. sporadically invaded by *Robinia pseudoacacia* and *Sambucus nigra*.

50. Kamenica brook-Dvorišće Vivodinsko (Vivodina) (16.2.1997) – Žumberak, MTB 0358, 180 m s. m.; *Robinia pseudoacacia* and *Sambucus nigra* shrubs.

51. Kamenica brook-Kamanje (Ozalj) (16.2.1997) – Žumberak, MTB 0358, 150 m s. m.; riparian forest of *Alnus glutinosa*, *Corylus avellana* with *Robinia pseudoacacia* inclusions.

52. Koče area (Brdo, Žrnovo), Korčula island (11.4.2003) – Southern Dalmatia, MTB 3068, 180 m s. m., tall humid evergreen forest of *Quercus* spp., *Laurus nobilis*, *Phyllirea* spp., *Viburnum* spp. and *Myrtus communis*.

53. Kolarska gora area, Mt. Medvednica (19.2.1995) – North-western Croatia, MTB 0161, 460 m s. m.; broadleaved forest.

54. Kolenka forest-Velika brook (Tkalec near Vrbovec) (20.3.1988) – Bilogorsko-Moslavačka region, MTB 0064, 150 m s. m.; *Alnus glutinosa* and *Salix* spp. streamside forest.

55. Končanica (Daruvar) (4.4.1994) – Bilogorsko-Moslavačka region, MTB 0368, 150 m s. m.; *Robinia pseudoacacia* and conifer plantation.

56. Koravac brook (Greda Sunjska near Sunja) (8.2.2004) – Posavina lowland, MTB 0665, 100 m s. m.; remnants of tall riparian forest of *Fraxinus angustifolia*, *Populus alba* and *Salix* spp.

57. Koruška brook, Križevci (2.4.1988) – Bilogorsko-Moslavačka region, MTB 9965, 120 m s. m.; *Robinia pseudoacacia* plantation.

58. Kosica area-Korita area (Vrbovsko) (2.5.2004) – Gorski kotar, MTB 0556, 640-650 m s. m.; mixed forest of *Abies alba*, *Fagus sylvatica*, *Picea abies* and *Acer pseudoplatanus* with *Corylus avellana*.
59. Križevci (2.3.1990) – Bilogorsko-Moslavačka region, MTB 9965, 160 m s. m.; deciduous forest of Alnus glutinosa, Populus sp., Carpinus betulus and Quercus robur.

60. Križna gorica peak (428), Mt. Medvednica (12.3.1995) – North-western Croatia, MTB 0062, 400 m s. m.; Robinia pseudoacacia shrubs.

61. Kupčina springs, Žumberak range (28.2.1998) - Žumberak, MTB 0258, 280 m s. m.; deciduous forest of Fagus sylvatica, Corylus colurna, Acer obtusatum with Sambucus nigra.

62. Kupčina river-Sopotski slap fall, Žumberak range (28.2.1998) - Žumberak, MTB 0258, 610 m s. m.; Fagus sylvatica, Ostrya carpinifolia and Salix sp.

63. Lonjišćina brook, Mt. Medvednica (21.2.1992; 8.3.1992) – North-western Croatia, MTB 0161, 300-320 m s. m.; deciduous forest of Quercus petraea, Carpinus betulus and Fagus sylvatica with its border settled with Robinia pseudoacacia and Sambucus nigra.

64. Lubenićica brook-Goli vrh peak (529), Mt. Medvednica (25.2.1996) – North-western Croatia, MTB 0161, 400 m s. m.; deciduous forest of Fagus sylvatica, Quercus petraea, Carpinus betulus, with Corylus avellana.

65. Špirancički lug forest (Križevci) (25.3.1988) – Bilogorsko-Moslavačka region, MTB 0065, 115 m. s. m.; riparian forest of Alnus glutinosa and Salix spp., with several substands of Robinia pseudoacacia and Sambucus nigra.


67. Mače (Zlatar) (1.5.1985) – North-western Croatia, MTB 9962, 240 m s. m.

68. Mačkov kamen area, Mt. Medvednica (12.3.1995) – North-western Croatia, MTB 0062, 560 m s. m., deciduous forest of Fagus sylvatica, Tilia platyphyllos and Fraxinus ornus.

69. Markovec brook, Mt. Medvednica (8.10.1995) – North-western Croatia, MTB 0161, 280 m s. m.; deciduous forest of Quercus petraea, Castanea sativa, Carpinus betulus with Acer pseudoplatanus and Fraxinus excelsior.

70. Martinšćak peak (346) (Duga Resa) (1.3.1997) – Plateau of Kordun with Pokuplje, MTB 0559, 340 m s. m.; grassland with few Tilia sp. trees and Robinia pseudoacacia shrubs.

71. Medveščak brook below Medvedgrad castle, Mt. Medvednica (12.3.1989; 16.3.1992) – North-western Croatia, MTB 0161, 420 m s. m.; riparian forest of Alnus glutinosa with Sambucus nigra in the forest of Quercus petraea, Carpinus betulus, Fagus sylvatica and Acer pseudoplatanus.

72. Medveščak brook at Kraljičin Zdenac mountain hut, Mt. Medvednica (16.3.1992) - North-western Croatia, MTB 0161, 520 m s. m.; deciduous forest of Quercus petraea, Carpinus betulus, Fagus sylvatica and Acer pseudoplatanus with Sambucus nigra.

73. Meglinec (Dugo Selo) (12.4. 1980) – North-western Croatia, MTB 0163, 110 m s. m.; Robinia pseudoacacia plantation.

74. Mihaljevac, Zagreb (21.2.1992) – North-western Croatia, MTB 0161, 190 m s. m.; Robinia pseudoacacia and Sambucus nigra shrubs.

75. Mikulići, Zagreb (12.4.1964; 2.2.1985; 10.3.1985; 23.2.2002) – North-western Croatia, MTB 0161, 280 m s. m.; deciduous forest of Fagus sylvatica, Quercus petraea with planted Pinus sylvestris and P. nigra interspersed with Robinia pseudoacacia.

76. Mikulići-Lukšići, Zagreb (30.1 1985) – North-western Croatia, MTB 0161, 260 m s. m.

77. Mikulička gorica area, Mt. Medvednica (15.2.1992; 15.3.1992; 14.3.1993; 9.3.2003) – North-western Croatia, MTB 0161, 310-380 m s. m.; deciduous forest of Quercus petraea,
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78. Miriča-štropana area-Rječica brook (Plitvički Ljeskovac), Mt. Mala kapela (28.4.1976) - Lika, MTB 1159, 600 m s. m.; mixed forest of *Abies alba* and *Fagus sylvatica*.
79. Mišarica area (Milna), Brač island (5.12.2002) – Central Dalmatia, MTB 2665, 400 m s. m.; evergreen tall forest of *Quercus ilex*, *Pinus halepensis*, *Phyllirea* spp., *Laurus nobilis* and *Myrtus communis*.
80. Novo Čiće (Velika Gorica) (8.3.2003) – Posavina lowland, MTB 0262, 100 m s. m.; flood forest of *Fraxinus angustifolia*, *Ulmus minor*, *Alnus glutinosa* and *Salix* spp.
81. Novo Selo (Selca), Brač island (1.4.2005) – Central Dalmatia, MTB 2667, 200 m s. m.; evergreen *Quercus ilex* and *Pinus halepensis* forest.
82. Novoselčina forest, Sesvete, Zagreb (25.2.1980) – North-western Croatia, MTB 0162, 160 m s. m.; deciduous forest of *Quercus petraea* and *Carpinus betulus*.
83. Obrašna forest (Grubišno Polje) (18.12.1994; 12.11.1995) – Bilogorsko-Moslavačka region, MTB 0269, 160 m s. m.; deciduous forest of *Quercus petraea*, *Fagus sylvatica*, *Prunus avium* and *Carpinus betulus* heavily invaded by *Robinia pseudoacacia*.
84. Obrovci forest (Grubišno Polje) (11.2.1995) – Bilogorsko-Moslavačka region, MTB 0269, 180 m s. m.; deciduous forest of *Quercus petraea*, *Fagus sylvatica*, *Prunus avium*, *Carpinus betulus* and *Acer platanoides*, completely without *Robinia pseudoacacia*.
85. Osoje area (Plemenitaš near Lukovdol) (14.10.2002) – Gorski kotar, MTB 0556, 460 m s. m.; deciduous forest of *Fagus sylvatica*, *Fraxinus excelsior*, *Acer pseudoplatanus* and *A. campestre*.
86. Oštrica area, Mt. Medvednica (24.4.1966) – North-western Croatia, MTB 0061, 800 m s. m.; deciduous forest of *Acer pseudoplatanus*, *Fraxinus excelsior* and *Fagus sylvatica*.
87. Otok-Podbrez (Prelog) (30.4.1984; 9.2.2002; 23.3.2006) – Međimurje, MTB 9665, 150 m s. m.; flood forest of *Fraxinus angustifolia*, *Alnus incana*, *A. glutinosa*, *Salix* spp. sporadically settled with *Robinia pseudoacacia* and *Sambucus nigra*.
88. Pesek, Križevci (20.12.1987) – Bilogorsko-Moslavačka region, MTB 9965, 180 m s. m.; *Picea abies* and *Pinus strobus* plantation with some broadleaved trees.
89. Petrov grob area, Gomirška kosa area, Mt. Velika kapela (8.4. 2007) – Gorski kotar, MTB 0656, 680 m s. m.; mixed forest of *Abies alba* and *Fagus sylvatica*.
91. Podbela area, Mt. Medvednica (21.4.1996; 25.1.2002) – North-western Croatia, MTB 0161, 520-570 m. s. m.; deciduous forest of *Quercus petraea*, *Fagus sylvatica*, *Carpinus betulus*, *Acer pseudoplatanus*, *A. campestre* with minor inclusions of *Robinia pseudoacacia*.
92. Podravska Subotica (17.1.1993) – Podravina lowland, MTB 9866, 180 m s. m.
93. Ponikve area, Mt. Medvednica (31.3.1996) – North-western Croatia, MTB 0161, 470 m s. m.; *Alnus glutinosa* streamside forest.
94. Prud area (Strmec near Samobor) (8.4.1988) – Posavina lowland, MTB 0160, 120 m s. m.; flood forest of *Fraxinus angustifolia*, *Quercus robur*, *Alnus glutinosa*, *Salix alba* and *Frangula alnus*.
95. Reka (Koprivnica) (4.5.1971) – Bilogorsko-Moslavačka region, MTB 9866, 160 m s. m.; *Robinia pseudoacacia* plantation.
96. Ribnica (Velika Gorica) (16.3.2003) – Posavina lowland, MTB 0262, 100 m s. m.; flood forest of *Fraxinus angustifolia*, *Alnus glutinosa* and *Salix* spp. with *Sambucus nigra*.

97. Ribnjak brook-Polovine, Gomirje (4.5.2004) – Gorski kotar, MTB 0656, 360 m s. m.; Pinus strobus and Pseudotsuga menziesii plantation with Sambucus nigra.

98. Risje area (Sesvetski Kraljevec near Zagreb) (12.3.2000) – North-western Croatia, MTB 0163, 130 m s. m.; Robinia pseudoacacia plantation with Sambucus nigra in deciduous forest of Quercus robur, Carpinus betulus, Prunus avium, Populus sp. and Corylus avellana.

99. Risnjak mountain hut, Mt. Risnjak (2.5. 1964) – Gorski kotar, MTB 0553, 1400 m s. m.; subalpine forest of Fagus sylvatica.

100. Rog peak (748), Mt. Medvednica (12.3.1995) – North-western Croatia, MTB 0062, 720 m s. m.; mixed forest of Fagus sylvatica, Sorbus aria, Tilia platyphyllos, Taxus baccata with Corylus avellana.


102. Rudarska gradna brook-Lampov breg peak (522), Samoborsko gorje range (6.1. 2001) – Žumberak, MTB 0260, 210 m s. m.; degraded deciduous forest of Carpinus betulus, Cornus sanguinea and Sambucus nigra.

103. Sava river-Puska (Jasenovac) (2.3.2002) – Posavina lowland, MTB 0666, 90 m s. m.; riparian stand of Salix sp. with Phragmites communis invaded by Amorpha fruticosa.

104. Sava river-Petruševac, Zagreb (28.2.1983) – Posavina lowland, MTB 0262, 100 m s. m., light riparian forest of Populus alba, Salix spp. and Fraxinus angustifolia with Corylus shrubs.

105. Sava river-Mičevac (Zagreb) (23.3.2002) – Posavina lowland, MTB 0262, 100 m s. m.; flood forest.

106. Sava river-Prud area (Podsused, Zagreb) (22.3. 1997; 28.3.1997; 11.3.1998) – Posavina lowland, MTB 0160, 120 m s. m.; neophyte vegetation of Helianthus tuberosus, Robinia pseudoacacia with Sambucus nigra.


108. Selca, Brač island (5.12.2002) – Central Dalmatia, MTB 2767, 180 m s. m.; evergreen forest of Quercus ilex, Arbutus unedo, Myrtus communis and Fraxinus ornus.

109. Sesvete, Zagreb (17.2.1980) – North-western Croatia, MTB 0162, 130 m s. m.; Robinia pseudoacacia plantation.


111. Slugovine brook (Krušljevec near Beletinec) (16.3.2003) – North-western Croatia, MTB 9764, 190 m s. m.; deciduous forest of Quercus petraea, Acer sp. with Betula pendula.

112. Srebrnjak, Zagreb (26.1.2003) – North-western Croatia, MTB 0161, 180 m s. m.; old orchard.

113. Sudovčina (Ludbreg) (5.4.1987) – Podravina lowland, MTB 9765, 160 m s. m.; Robinia pseudoacacia plantation with Sambucus nigra.

114. Sukorova poljana area (Vrbosko) (10.4.2004) – Gorski kotar, MTB 0656, 430 m s. m.; mixed forest fringe with Carpinus betulus, Juniperus communis, Corylus avellana and Prunus avium stand.

115. Suvača forest-Šetnik brook (Cvetnič Brdo) (28.2.1997) – Posavina lowland, MTB 0461, 150 m s. m.; deciduous forest of Quercus petraea, Carpinus betulus and Populus
The genus *Sarcoscypha* in Croatia. Ecological and distribution patterns

tremula with Betula pendula.

116. **Sv. Ilija church-Isine brook (Jezerne)**, Žumberak range (21.2.1998) - Žumberak, MTB 0258, 680 m s. m.; riparian forest of Salix spp. with Prunus avium and Sambucus nigra.

117. **Svi Sveti church (Gornji Humac), Brač island** (7.12.2002) – Central Dalmatia, MTB 2766, 360 m s. m.; tall evergreen forest of Quercus ilex, Laurus nobilis and Fraxinus ornus.


119. **Mt. Klekovača** (22.5.1970) – Bosnia-Herzegovina, 1400 m s. m.; mixed forest of Abies alba and Fagus sylvatica.

120. **Šimunov grad area** (Mirkovica peak, 1286), Mt. Velika kapela (18.5.1996; 25.5.1996; 15.5.1999) – Gorski kotar, MTB 0756, 1100 m s. m.; mixed forest of Picea abies, Sorbus aucuparia, Acer pseudoplatanus, Oreoberzogia fallax and Ribes alpinum.

121. **Široko breže forest** (Križevci) (15.3.1987; 18.3.1988; 19.3.1989) – Bilogorsko-Moslavačka region, MTB 9965, 160 m s. m.; deciduous forest of Quercus robur, Alnus glutinosa and Carpinus betulus with some inclusions of Robinia pseudoacacia.

122. **Štvanja area** (Repaš) (15.1.1999) – Podravina lowland, MTB 9868, 120 m s. m.; flood forest of Quercus robur, Alnus glutinosa and Frangula alnus.

123. **Štvanja area-Cenkovan (Repaš)** (15.1.1999) - Podravina lowland, MTB 9868, 120 m s. m.; flood forest of Fraxinus angustifolia, Quercus robur and Acer campestre with Sambucus nigra.

124. **Tepice area** (Mirkovica peak 1286), Mt. Velika kapela (30.4.1994) – Gorski kotar, MTB 0756, 990 m s. m.; deciduous forest of Fagus sylvatica, Acer pseudoplatanus and Fraxinus excelsior.

125. **Teškovec peak** (463), Mt. Medvednica (21.11.1989) – North-western Croatia, MTB 0161, 410 m s. m.; degraded deciduous forest without Robinia pseudoacacia.


127. **Tugonica (Marija Bistrica)** (23.3. 2002) – North-western Croatia, MTB 9962, 150 m s. m.; deciduous forest of Quercus petraea, Carpinus betulus and Fagus sylvatica.

128. **Turopoljski lug forest** (Lekenik) (23.3.1993) – Posavina lowland, MTB 0363, 100 m s. m.; flood forest of Fraxinus angustifolia, Alnus glutinosa and Quercus robur.

129. **Tuškanac park, Zagreb** (12.2.1992; 15.2.1995) – North-western Croatia, MTB 0161, 140 m s. m.; city park with deciduous trees.

130. **Varoško rebro area, Mt. Medvednica** (26.1. 1980; 3.3.2002) – North-western Croatia, MTB 0161, 380-400 m s. m.; broadleaved forest of Quercus petraea, Carpinus betulus, partly invaded with Robinia pseudoacacia.

131. **Velika lokva area** (Mirkovica peak 1286), Mt. Velika kapela (30.4.1994) – Gorski kotar, MTB 0656, 1000 m s. m.; deciduous forest of Fagus sylvatica, Acer pseudoplatanus, Sorbus aucuparia and Oreoberzogia fallax.

132. **Velika peč peak** (667), Mt. Medvednica (12.3.1995) – North-western Croatia, MTB 0062, 640 m s. m.; deciduous forest of Fagus sylvatica, Sorbus aria, Tilia platyphyllos with Corylus avellana.
133. Veliki dol area (Rude), Samoborsko gorje range (27.2.1966) - Žumberak, MTB 0260, 400 m s. m.

134. Veli drmun area (Glavotok near Malinska), Krk island (13.3.2004) - Kvarner, MTB 0952, 50 m s. m.; thermophilic mixed forest of Quercus pubescens, Fraxinus ornus, Carpinus orientalis, Quercus ilex and Phyllirea sp.

135. Veliki Kalnik castle, Mt. Kalnik (18.4. 1987) – North-western Croatia, MTB 9864, 480 m s. m.; Robinia pseudoacacia plantation.

136. Veliki Pažut area (Kotoriba) (16.4.2000) - Međimurje, MTB 9667, 130 m s. m.; tall riparian forest of Populus nigra, Alnus incana, A. glutinosa, Salix spp. with Cornus sanguinea and Sambucus nigra.

137. Veliki potok brook, Mt. Medvednica (14.3.1993) – North-western Croatia, MTB 0161, 330 m s. m.; riparian forest of Alnus glutinosa and Salix spp.

138. Vinogradski put area-Januševc castle (Brdovec near Zaprešić) (3.4.2004) – North-western Croatia, MTB 0160, 180 m s. m.; degraded deciduous forest with high amount of Robinia pseudoacacia and Sambucus nigra.

139. Vranilce peak (643), Mt. Kalnik (1.3.1987; 17.1.1988; 3.2.1990) – North-western Croatia, MTB 9864, 520-560 m s. m.; rocky steep slopes much covered with Robinia pseudoacacia.


ABBREVIATIONS OF PERSONS WHO TREATED AND/OR COLLECTED THE MATERIAL

RESULTS

Sarcoscypha austriaca (Beck ex Sacc.) Boud.

OCCURRENCE AND DISTRIBUTION
This species is most frequent of all treated species and is very widely distributed. In Croatia it is spread from Mediterranean thermophilic deciduous forests through almost all major habitat forest types of continental planar and colline zones to the highest forest stands in subalpine zone. However, the species has relatively sharp two distribution peaks, one situated in the lowland forests and plantations rich in Alnus and Salix species as well as with Robinia

Fig. 1 (right) Ascus in *S. austriaca* ruptured by secondary spores (mitosporic) richly produced on germinated submature ascospores while still in asci (CNF 2/1222). Horizontal bar = 20 µm.

Additionally, there are a number of tree species revealed as apparently new hosts for *S. austriaca* (Fig. 7) some of which are of particular interest: (1) lowland areas - *Sambucus nigra* (one of the species dominant substrate), *Picea abies* (repeatedly found in several *Picea abies* plantations) and *Cornus sanguinea*; (2) montane areas – *Sorbus aucuparia* and *Oreoberzogia fallax*. There are few other hosts known but are apparently insignificant due to their low frequency (single collections).

**Notes**

**I - Monitoring apothecial development**

The monitoring of the apothecial development in natural conditions was performed at one occasion. The monitoring plot approx. 10 x 5 m was selected in autumn 1990 in a part of Zagreb situated on hilly slopes of Mt. Medvednica, at the steep eastern slope, 170 m s. m. (Loc. 118). It consists of dense, shady thicket of *Robinia pseudoacacia*, *Corylus avellana*, *Sambucus nigra* and *Cornus sanguinea* shrubs. This particular site is continuously settled with *Sarcoscypha austriaca*, with apothecia repeatedly recorded there for few preceding years colonizing fallen branches of both *Robinia pseudoacacia* and *Sambucus nigra*. At the end of October 1990, a 20 mm thick *Robinia* branch with its leaves still attached was found as recently fallen on the ground. At the same time one living *Robinia* branch of the same

thickness was deliberately broken off and placed near the first one. Both branches were marked and left in their original position for subsequent monitoring.

Fig. 2 monitoring the apothecial development in *Sarcoscypha austriaca*. Apothecial diameter (in milimetres) is shown by y-axis. Freezing, wet and dry substrate conditions are presented with the appropriate symbols at the bottom of the table.

Next year during January and February, and later during November and December, no apothecia were found on these branches. First few apothecial primordia were recorded in the beginning of January 1992 after partial snowmelt but only on a spontaneously fallen branch, at that time slightly immersed in the soil by its one end. Deliberately broken branch stayed without apothecia. Both branches were partially covered with thin *Corylus* litter. Shortly after, branches were strongly moistened after heavy rain in the mid January and ice crystals were found only on the undersides of the fallen leaves. The charting of the fructification and first apothecial measurements were taken on January 19th and the procedure was repeated in every 6-8 days afterwards. Few centimeters thick, continuous snow bed appeared again from January 22nd and lasted to January 30th. Dry conditions prevailed between of 8th and 12th of February followed by new rain in mid February. A week of strong dry period occured from the beginning of March, with a new rain followed afterwards.

The monitoring performed in 1992 on apothecial development of selected fructification is shown on Fig. 2. It is obvious that apothecia of the monitored fructification has reached peaks of their development three times in three groups of fruitbodies (a & b; c-g and h & i).
Smallest apothecia and those that appeared subsequently never had opportunity to grow and get matured (j-o). During snow coverage apothecia grew negligible. Subsequent snowmelt moistened the soil and the substrate, followed by the temperature increase caused strong development in the largest apothecia. The others grew slowly or not at all. Two dry periods caused total drying of the smallest apothecia, while those that undergone rapid development succeeded to reach maturity but their apothecia usually cracked at the margin. All apothecia reached maturity at apothecial diameter of 18 mm or above at which point they stopped with further growth and usually started with intensive sporulation in approx. 24 hours. Entire sporulation period lasted at least for 3-5 days.

II – «Short» mitosporogenesis as apothecial respond to sudden dry conditions

Contrary to the closely related S. coccinea which produce mitospores (sympoduloconidia) only on mycelium (cf. Baral 1984), S. austriaca may produce mitospores directly on ascospores, even while still in closed asci (Fig. 1). We can regard such behaviour as shortened anamorphosis. In this way the species surely can quickly adapt to abrupt dry conditions. Our material repeatedly displayed this feature especially in collections containing immature apothecia that stopped with growth due to sudden dry conditions appeared in long, warm and dry periods during winter. Such apothecia, still with strongly inrolled margin were frequently found dusted with white powder. All analyses of such apothecia showed that this powder was a mass of developed and partly released secondary spores.

Specimens examined

The genus *Sarcoscypha* in Croatia. Ecological and distribution patterns


*Sarcoscypha coccinea* (Scop. : Fr.) Lambotte

**Occurrence and distribution**

This species is fairly frequent and very widely distributed. In Croatia it is spread from Mediterranean mixed evergreen/deciduous forests through almost all major habitat forest types of continental planar and colline zones to the highest forest stands in subalpine zone. However, the species has sharp distribution peak in the colline to montane zone in deciduous forests rich in *Carpinus betulus*, *Corylus avellana* and *Fagus sylvatica*. There are four tree species revealed as apparently new hosts for *S. coccinea* (Fig. 7): *Quercus ilex* in meso-mediterranean area, *Ostrya carpinifolia* in subtherophilic continental deciduous forests, *Sorbus aria* in calciphilous montane deciduous forests and *Juglans regia* in orchards. The species is found as low as 90 m s. m. in Posavina lowland to 1400 m s. m. in the subalpine forest below Risnjak peak (1528 m).

**Specimens examined**

Loc. 6, on *Carpinus betulus* three records without voucher, **det. N.M.; Loc. 7**, on *Corylus*
Map 2 Known distribution of *S. coccinea* (filled circles) and *S. coccinea* with *S. jurana* (empty circle) in Croatia.

*Sarcoscypha jurana* (Boud.) Baral

**Occurrence and distribution**

This species is quite rare in Croatia and it is not surprising as it has the narrowest substrate range of all species concerned. It is confined only to the rotten branches of *Tilia*. *Tilia* species has generally very low frequency in Croatian natural and seminatural habitats. Montane calciphilous relict *Tilio-Quercetum* forests (*T. platyphyllos*), Pannonic forests of pedunculate oak and common hornbeam with *Tilia tomentosa* (RAUŠ & al. 1992) and mediterranoid calciphilous continental *Tilio-Quercetum dalescambii* stands (*T. cordata*, BERTOVIĆ & LOVRIĆ 1987) are the only significant forest types in Croatia that contain higher portion of *Tilia* species and they all occupy very small areas. Another habitat with significant portion of *Tilia platyphyllos* are town parks in the continental area of Croatia.

Town parks with *Tilia* species and *Tilio-Quercetum* stands in vicinity of Zagreb have been intensively researched during last 15 years with the single collection of *S. jurana* found in *Tilio-Quercetum* stand on the eastern part of Mt. Medvednica (Map 2). *Tilio-Quercetum dalescambii* stands are under ongoing research, while pedunculate oak and common hornbeam forest
with *Tilia tomentosa* is not covered with the research yet. The species is recorded in Croatia for the first time.

**Specimens Examined**


*Sarcoscypha macaronesica* Baral et Korf

**Occurrence and Distribution**

This species has clear Mediterranean distribution and its occurrence is confined to tall, more or less purely evergreen forests dominated by *Quercus* and/or *Laurus* species on Croatian islands and small peninsulas of Dalmatia (Korčula, Brač and Lapad). It is so far known only from five localities (Map 1).

**Notes**

The species is here recorded for Croatia for the first time since Foehl (1986) did not specified neither the locality nor the material on which he based his short notes on the species. The existence of exsiccata of *S. macaronesica* in his material is confirmed in this research. He collected the species in former luxuriant evergreen forest (subsequently vanished under intensive urbanization) in the Dubrovnik area. The species is generally considered as threatened in Croatia and therefore included in Red List of Fungi of Croatia (Tkalcic, Mesic & Matocec 2005).

**Specimens Examined**


**Discussion**

**Species frequency and biogeography**

All three special studies undertaken so far on European *Sarcoscypha* species, one for Central Europe and Western Mediterranean area (Baral 1984), another in South-eastern Austria (Pidlich-Aigner 1999) and the present one, carried out in Croatia confirmed *S. austriaca* as most frequent species. It has almost two times higher frequency than *S. cocinea* in Central Europe (Baral 1984), more than 2.5 times higher frequency in Croatia and has over seven times higher frequency in Syria (Pidlich-Aigner 1999), see Fig. 3. It is widespread species, but with more or less continental to Baltic main distribution and is seemingly absent or very rare in warm Atlantic-Mediterranean zone (see distribution map in Baral, 1984).
The genus *Sarcoscypha* in Croatia. Ecological and distribution patterns

However, *S. coccinea* is far from being rare, occupying wide areas along the Europe, from warm Atlantic-Mediterranean zone to the Baltic and Central European continental regions. Two remaining species are much rarer or fairly limited in distribution. *S. jurana* is obviously quite common in the Continental Europe from Northern carbonate Alpine belt and Tatra mountains northwards (Baral 1984).

![Graph showing European Sarcoscypha species frequencies](image)

Fig. 3 European *Sarcoscypha species* frequencies after three separate studies (bar height represents collections with known substrata): Central Europe and Western Mediterranean (Baral 1984), South-eastern Austria (Pidlích-Aigner 1999) and Croatia (this paper).

Two studies that covered area South-eastern from the central Alpine ridge showed that this species is apparently rare there. A number of aimed field trips undertaken in Croatian habitats likely to house the species resulted only with a single collection. On the other hand, *S. macaronesica* is confined to Mediterranean areas with full grown tall evergreen forests of *Quercus* and *Laurus* species. It seems that this species has rather low frequency even under its optimal areas. Species frequencies are summarized in Fig. 3.

**Fructification dynamics and vertical distribution**

Our data on apothecial development and sporulation season largely correspond with those of Pidlích-Aigner (1999). Apothecia of *S. austriaca* found in autumn are rare, and they are always immature. In such cases apothecia are overwintered and can hardly sporulate before February. On the contrary, there are number of mature apothecia of *S. coccinea* found from late October to the end of December. The peak of the fructification period of the species falls in mid February, while in *S. austriaca* falls in March to April (Fig. 4). Differences between two species in montane to subalpine areas (localities approx. above 500 m s.m.) are slightly lesser, where one can found ripe apothecia of both species from March to May due
to colder climate (not shown). *S. macaronesica* have narrowed fructifying period that falls mainly in mid winter when heavy rain occur in its Mediterranean habitats. Two collections found in March and April were overmature and highly decayed.

Although both *S. austriaca* and *S. coccinea* are vertically widely distributed (i.e. present in all vertical classes) they show considerable differentiation (Fig. 5). *S. austriaca* has highest frequency in planar lowland (0-140 m class) dominated by flood forest types and in colline belt (140-400 m class), while *S. coccinea* has maximal frequency in colline to montane belts (400-800 m). We cannot ascertain the situation in altimontane and subalpine areas because they are presently still underexplored in comparison to the lower areas with the lower altitude in Croatia.

Fig. 4 Apothecial maturation dynamics in Croatian *Sarcoscypha* species. Collections containing immature and decayed old apothecia were not taken into account, as well as those found above 500 m s. m.

![diagram showing vertical distribution of Sarcoscypha species](image)

Fig. 5 Vertical distribution of the Croatian *Sarcoscypha* species.

**Substrate preferences**

Data summarized in Fig. 6 clearly show differences in substrate preference in all *Sarcoscypha* species with the *Salix* branches being the only substrate type with similar preference shared between *S. austriaca* and *S. coccinea*. Dead branches of evergreen trees
(Quercus spp. and Laurus spp.) are almost exclusively occupied by S. macaronesica and Tilia branches by S. jurana. Fallen branches of deciduous ulmacean, rosacean and fagalean species (except Betulaceae), especially those from genera Fagus, Corylus, Carpinus, Ulmus and Prunus are the main substrata for S. coccinea. To the contrary, S. austriaca colonize mainly aceracean, betulacean, salicacean, caprifoliacean and fabacean woody substrata (mainly from genera Alnus, Robinia, Acer, Salix and Sambucus).

Our study resulted in some new substrate type records for certain species (Fig. 6, 7). Most important revealed new host is Sambucus nigra, which is one of the main substrates for S. austriaca in planar to colline biotopes of Croatia. Seems it is recorded here for the first time and, together with Robinia pseudoacacia makes most frequent habitat as these two plant species are frequently found together in spontaneous association in lowland to colline Croatia where original vegetation is disturbed or degraded. Picea abies branches are also newly recorded substrate on which S. austriaca is repeatedly found. Together with Perić’s data on Montenegrin Sarcoscypha species (another article, this volume), this species is recorded on coniferous substrate for the first time.

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Fig. 6 Main substrate type frequencies (marked in grey field) in European species of Sarcoscypha after three separate studies (numbers indicate collection quantities). Bolded numbers designate frequency above 25% of total collections per each study; while normal number in grey field designate their frequency 10-25% of total collections.

Spatial relations among species
The species S. coccinea, S. jurana and S. macaronesica are not found to occur together in any particular locality in Croatia so far and they can be regarded as spatially separated. On the
Fig. 7 Substrate type frequencies Croatian species of Sarcoscypha
(bar height represents collections quantity).

other hand, there are many localities in which S. austriaca and S. coccinea were repeatedly found together (Fig. 8). However, these two species were never found together on the same substratal unit. Similar situation occur in Austria (Pidlich-Aigner 1999).

Habitat preferences

When we take into account only natural habitat types in Croatia, Sarcoscypha coccinea and S. austriaca have their population contact only in lowland ground water dependent forests and in subalpine stands. According the Fig. 9 we can suppose that S. austriaca became significantly more spread and its frequency have been considerably increased when Robinia pseudoacacia was introduced from North America and later extensively spread along Croatian continental lowland by man in past few centuries. Under these circumstances S. austriaca and S. coccinea might came in significantly wider population contact. Other species are apparently in negligible spatial contact as they inhabit different biotopes.

In comparison to the other special research done on European Sarcoscypha species, there is general agreement in species habitat type preferences (cf. Baral 1984, Pidlich-Aigner 1999).

The main habitats of S. austriaca indicated in all three studies are either deciduous forests dependent on high level regime of both ground and flood water, regardless of vertical
The genus *Sarcoscypha* in Croatia. Ecological and distribution patterns

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Fig. 8 Croatian localities exclusively settled with single *Sarcoscypha* species (middle rows/columns) and those settled with a pair of species (corner fields and the central one).

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<th>S. austriaca</th>
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<td>S. jurana</td>
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<td>(calciphilous montane deciduous forest rich in <em>Tilia</em>)</td>
<td>colline often heavily degraded deciduous forest and <em>Prunus</em> orchards invaded by <em>Robinia</em>, city parks <em>Alnus-Salix</em> riparian forest, <em>Fraxinus</em> and <em>Populus</em> flood forest, altimontane mixed forest</td>
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<td>(calciphilous montane deciduous forest rich in <em>Tilia</em> for <em>cocc.-jur.</em>/ none for <em>aus.-mac.</em>)</td>
<td>colline to montane deciduous and mixed <em>Abies</em> forest, orchards without <em>Robinia</em> and/or <em>Sambucus</em></td>
</tr>
<tr>
<td>none</td>
<td>humid evergreen <em>Quercus-Laurus</em> forest</td>
</tr>
<tr>
<td></td>
<td>semideciduous forest with <em>Quercus ilex</em></td>
</tr>
</tbody>
</table>

Fig. 9 Croatian main habitat types specific to each *Sarcoscypha* species (middle rows/columns) and their main mutual habitats (corner fields and the central one). Possible mutual habitats are given in parentheses. Anthropogenous habitats are marked with grey.

zones (habitats with domination of all three *Alnus* species - *A. glutinosa*, *A. incana* and *A. viridis*; *Salix* species), anthropogenous stands dominated by *Robinia pseudoacacia* or *Robinia* inclusions in various types of deciduous forests in planar to colline zone, and deciduous altimontane to subalpine forests with high frequency of *Acer* species. *S. coccinea* is most frequent in colline to montane deciduous and mixed forests dominated by *Fagus sylvatica* accompanied with *Carpinus betulus* and/or *Corylus avellana* and to lesser degree, in lowland forests rich in *Ulmus* and *Salix*. To the contrary, ecologically two far more stenothermal species occur in few habitat types. *S. macaronesica* is confined to evergreen Mediterranean forests dominated with sclerophyllous *Quercus* and/or *Laurus* species, while *S. jurana* is confined to the deciduous montane forests rich in *Tilia* species.

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LITERATURE CITED


