A dichotomous Key to the Genera of Marine Fungi recorded on Rhizophora spp.

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A dichotomous taxonomic key to the genera of marine fungi reported from Rhizophora spp. in mangroves is presented. It includes 3 basidiomycetous, 85 ascomycetous and 51 anamorphic genera of fungi totaling 139 genera.

[Key words: Mangroves, taxonomic keys, ascomycetes, basidiomycetes, anamorphic fungi]

Introduction
Keys to large number of marine fungi, 321, 444 or 530 have been proposed. However, it is difficult to find a Rhizophora-associated marine fungus from such a large number. On the contrary, keys to particular host or location make identification easier. An attempt has been made here to present a dichotomous key to genera of marine fungi occurring on species of Rhizophora L. Rhizophora spp. occur in mangroves and are good hosts for colonization of marine fungi. There are 201 marine fungi that have so far been reported on Rhizophora spp. belonging to 139 genera. In the present dichotomous key these genera have been covered including 3 basidiomycetous, 85 ascomycetous and 51 anamorphic genera. The occurrence of some of the fungal genera such as Eutypa, Zopfiella and Rhabdospora is doubtful. Therefore, if more records are found they may be placed under Rhizophora as otherwise the host may be double checked.

The key to the marine fungi occurring on Rhizophora spp. is provided below. The key has basically followed Jones et al. and Ellis.

Dichotomous key to genera of marine fungi on Rhizophora spp.

1. Sexual spores through meiosis. 2
1’. Asexual spores, namely, conidia. Anamorphic fungi (84)

2. Meiospores primarily exogenous, born on basidia or similar structures. Basidiomycota (3)
2’. Meiospores produced endogenously formed in ascii. Ascomycota (5)

3. Basidioma sub-globeose, puff ball-like, no stalk, basidiospores with appendages. Nia
3’. Basidiomyca pyhllloid, funnel-shaped

4. Basidioma white, surface hairs smooth, Halocyphina
4’. Basidioma yellowish to ochre yellow, cup-like, Calathella

5. Ascomata with bitunicate asci. 6
5’. Ascomata with unitunicate asci

6. Ascomata apothecoid or hysterothecioid. 7
6’. Ascomata different

7. Ascomata apothecoid or discoid. 8
7’. Ascomata hysterothecioid, transversely multiseptate ascospores. Hysterium

8. Asci are externally provided with amyloid caps, marine species with uniseptate, brown ascospores. Dactylospora
8’. Asci fissitunicate, non-amyloid, transversely multiseptate, hyaline ascospores. Patellaria

9. Ascomata under a or surrounded by a thallus. Melaspilea
9’. Ascomata developing differently

10. Ascomata lirelliform with an opening that runs the length of the ascoma, asci with an ocular chamber and amyloid; ascospores one-septate, with a mucilaginous sheath. Melaspilea
10’. Ascomata developing under a dark stroma, subglobeose to fusiform, asci bitunicate with non
amyloid apical ring, ascospores ellipsoidal to fusiform, 3-septate, ..........Pyrenographa

10. Ascomata immersed, asci with an ocular chamber, ascospores fusiform, dark brown the end cells paler, 9-13-distoseptate, ..........Mauritania

11. Ascomata lacking paraphyses, pseudoparaphyses or paraphysoids, asci globose, ellipsoidal or subcylindrical………………..12

11'. Ascomata with cellular or trabeculate pseudoparaphyses; asci cylindrical, clavate, oblong saccate………………………………….17

12. Ascomata formed by lysigenous locules within stromatic tissue, interasal tissue lacking, asci fissitunicate……………………………..13

12'. Ascomata small, immersed in host tissue, asci ovoid to saccate to subcylindrical, ascospores hyaline to slightly pigmented, mostly 1-septate …………………..Mycosphaerella

12''. Paraphyses present, ascospores 3-6 septate………………………………….Sphaerulina

13. Ascospores with central cells brown and end cells hyaline, ......................Passeriniella

13'. Ascospores different..............................14

14. Ascomata cleistothecial without a definite centrum, semi-immersed; asci evanescent at an early stage .........................Coronopapilla

14'. Ascomata different; asci widely clavate……..15

15. Ascomata superficial with stalk, ascospores one-septate, with large brown cell and short hyaline cell…………………………..Manglicola

15'. Ascomata without a stalk; ascospores different………………………………….16

16. Ascospores hyaline with fine halo of fine hairs, appendages surrounding the ascospores completely at maturity ..........Capillataspora

16'. Ascospores with tuberculate wall and surrounded by a sheath.................Belizeana

17. Ascospores 1-septate…………………………..18

17'. Ascospores multiseptate...........................29

17''. Ascospores muriform…………………………...40

18. Ascospores hyaline…………………………..19

18'. Ascospores brown…………………………..25

19. Ascospores with central septum……………….20

19'. Ascospores with eccentric septum and a sheath..........................Didymella

20. Ascospores lacking appendages or sheaths ........................................Acrocordiopsis

20'. Ascospores with appendages or mucilaginous sheaths..............................21

21. Ascomata with lenticular appendages on sides..........................Paraliomyces

21'. Ascomata with mucilaginous sheaths and lack appendages..........................22

22. Ascomata ostiole slit-like, ascospores with mucilaginous appendages ......................23

22'. Ascomata not slit-like.........................24

23. Ascospores fusiform, 3-septate, longer ..............................................Rimora

23'. Ascospores fusiform, 3-septate, shorter ..............................................Lophiostoma

23''. Ascospores with 4th cell usually the largest, tapering at the ends sharply ......Splanchnonema

24. Asci with ocular chamber but no apical apparatus, ascospores hyaline, surrounded by a gelatinous sheath .........................Halomassarina

24'. Ascii with an ocular chamber and an apical apparatus, ascospores hyaline with or without a gelatinous sheath or cap ..............Morosphaerina

25. Ascomata immersed in substratum, multiloculate (several ascoma with central pore), ascospores with a delicate sheath, ......................Helicascus

25'. Ascomata different..............................26

26. Ascomata mammiform, ascospores with bipolar germ tubes ......................Caryosporella

26'. Ascomata superficial or semi-immersed, ascospores brown..................Kirschsteiniothelia

26''. Ascomata immersed in substratum. ....27

27. Ascospores verrucose..............................28

27'. Ascospores not verrucose but have longitudinal striations......................Lineolata

28. Ascospores brown, verrucose with dark band at septum........................Didymosphaerina

28'. Ascospores dark brown with verrucose ornamentation........................Verruculina

29. Ascospores 1-3 septate...........................30

29'. Ascospores more than 3-septate..........................33

30. Ascospores pale yellowish to brown..............31

30'. Ascospores hyaline ................................32
31. Ascomata soft, superficial with setae ........................................... Tubeufia
31'. Ascomata not with setae, small, soft, superficial, ascospores in tetrads........... Sporormiella

32. Ascomata superficial, crater-like ..................................................Ascocratera
32'. Ascomata immersed, ascospores with or without a sheath...................... Massarina

33. Ascomata with septa at the ends, centrally wider and tapering towards ends, ........................................ Biatriospora
33'. Septa uniformly spread along ascospores............................................

34. Ascomata superficial, ascospores with a sheath, 7-14 septate................. Massariosphaeria
34'. Ascomata immersed or erumpent..................................................

35. Ascospores versicolored.................................................................36
35'. Ascospores hyaline or uniformly colored............................................37

36. Ascomata immersed erumpent, ascospores striated ................................Astrosphaeriella
36'. Ascomata immersed, ascospores with end cells hyaline........................ Byssothecium

37. Pseudoparaphyses trabeculate..................................................38
37'. Pseudoparaphyses cellular..............................................................39

38. Ascomata erumpent, ascospores fuscous .................................................. Trematosphaeria
38'. Ascomata completely immersed, ascospores hyaline.............................. Quintaria

39. Ascomata with thick peridial wall ............................................. Leptosphaeria
39'. Ascomata with thin peridium ......................................................... Phaeosphaeria

40. Ascospores with lighter end–cells............................................. Aigialus
40'. Ascospores uniformly brown or colorless, hyaline..............................

41. Ascomata in a pseudostruma or coloured stroma or absent, ascospores lack germ pores ...............................................42
41'. Ascomata developed within stroma of fungal tissue, black, perithecial, asci with J- apical apparatus, ascospores with germ pores.............................................75

42. Ascoma perithecial, rarely eleistothecial, asci thin-walled often deliquescing, ascospores septate, hyaline to brown.................................43
42'. Ascomata perithecial, rarely eleistothecial, asci often thick-walled, ascospores 0-1-septate........................................................72
42''. Ascomata, asci and ascospores different ..................................................74

43. Ascomata in a stroma, perithecial, with short necks, often brightly coloured........44
43'. Ascomata rarely in a stroma, with long necks, ascospores hyaline rarely coloured, 1-many-septate, often with appendages or sheaths or both..............................................................49
44. Ascospores unicellular globose or oval ............................................. Payosphaeria
44'. Ascospores septate .................................................................

45. Ascomata brightly colored ............................................................46
45'. Ascomata color is pale or black, with appendages ........................................48

46. Ascospores one-septate, colored.................................................47
46'. Ascospores 1-3-septate, colored in masses ........................................ Swampomyces

47. Ascomata yellow to pale brown, epapillate .............................................Heleococcum
47'. Ascomata orange, papillate ......................................................... Kallichroma

48. Ascospores 1-septate with appendages ............................................. Etheirophora
48'. Ascomata 3-septate, with forked appendages........................................ Torpedospora

49. Ascomata with thick peridial wall ............................................. Leptosphaeria
49'. Ascomata with thin peridium ......................................................... Phaeosphaeria

50. Asci without an apical pore, ascospores filiform, .................................................. Bathyascus
50'. Asci with an apical pore, ascospores spherical or ellipsoidal...................... Thalassogena

51. Ascomata 1-septate.........................................................52
51'. Ascomata 1 to many-septate......................................................69

52. Ascospores with no appendages .................................................53
52'. Ascospores with polar and/or equatorial appendages or with sheaths ................56

53. Asci deliquescent early............................................................... Nais
53'. Asci persistent..........................................................54

54. Asci persistent, no retraction of the plasmalemma, tip thimble-shaped......... Lignincola
54'. Asci with plasmalemma retracted.............................................55
55. Ascospores without unfurling bipolar appendages ........................................... Aniptodera  
55'. Ascospores with a faint sheath ........................................... Neptunella

56. Ascospores with a single polar appendage ...........................................  
56'. Ascospores with bipolar hamate appendage, or polar and equatorial appendages ........................................... 60

57. Ascospores with a hamate polar appendage ...........................................  
57'. Ascospores with an ephemeral drop of polar mucilage, becoming 2-4-septate on germination ........................................... Okeanomyces

58. Ascomata formed beneath a stroma, ascospores with unipolar appendage ........................................... Ophiodeira

59. Ascospores oval, with unipolar appendage ...........................................  
59'. Ascospores filiform, ascomata thick-walled ........................................... Oceanitis

60. Ascospores with polar unfurling appendages ........................................... 61

61. Polar appendages emerging from a hood-like structure ........................................... Cucullosporella

62. Ascospores longer than 35 µm and wider than 12 µm ........................................... 63

63. Ascospores wider than 14 µm ........................................... 64

64. Ascospores appendages not extending to the middle septum ........................................... Halsarpheia

65. Ascospores 21-31 x 8-11 µm ........................................... Panorbis

66. Ascospores with polar and/or lateral appendages ........................................... 68

67. Ascospores with 2 sub-polar appendages ........................................... Antennospora

68. Exosporic sheath of ascospores is highly fibrillar (mucilaginous), slug-like ........................................... Limacospora

69. Ascospore appendages broad strap-like ........................................... Haligena

70. Ascospores appendages hamate, unfurling in water, ascospores narrower than 7 µm ........................................... Oceanitis

71. Polar appendages spine-like, equatorial appendages formed by fragmentation of an exosporic sheath ........................................... Corollospora

72. Ascospores 0-septate ........................................... 73

73. Ascus thick-walled, with an ocular chamber with a net-like apical apparatus, ascospores hyaline ........................................... Hapsidascus

74. Ascospores 13-17-septate, yellow, striate ........................................... Pedumispora

75. Ascospores 0-septate ........................................... 76

76. Ascospores lacking appendages or a sheath ........................................... 82

77. Ascospores with germ slits ........................................... 78

78. Ascomata immersed in wood, ascospores with or without a sheath, or basal cell ........................................... Anthostomella

79. Ascomata immersed in wood, ascospores allantoids, hyaline ........................................... Eutypa

80. Ascospores appendages hamate, unfurling in water, ascospores narrower than 7 µm ........................................... Cryptosphaeria
80. Asci filiform, early deliquescent; ascospores, with apical cap-like ends filled with mucilaginous substance. ……………………………Lulworthia
80'. Ascosporas not filiform ………………….81

81. Ascomata ostiolate, ascospores with larger upper cells and shorter lower cells. …………Zopfiella
81'. Ascosporas different ……………………82

82. Ascospore middle cells brown and end cells hyaline ……………………………….Savoryella
82'. Ascospores uniformly colored…………….83

83. Ascospores 0-1-septate, constricted at the septa, hyaline or occasionally turning into light brown at maturity. ……………………………Gnomonia
83'. Ascospores 0-3-septate, hyaline, slightly constricted at the septa …………Marinosphaera

84. Conidia produced on hyphae and not in fruit bodies………………………………………….85
84'. Conidia produced in fruit bodies……………121

85. Conidigenous cells thalli………………….86
85'. Conidigenous cells blastic…………………87
85''. Nematode trapping devices produced by hyphae……………………………………120

86. Conidiophores and conidia absent; chlamydospores only produced, filiform, apical single or in chains filamentous 11-43 septate ……………………………Xylomyces
86'. Conidiophores macronematous, meristematic, conidia in tetrads on natural samples………………Trimmatostrama

87. Conidigenous cells holoblastic…………...88
87'. Conidigenous cells tretic or enteroblastic ………………………………………113

88. Conidigenous cells all or mostly integrated ………………………………………89
88'. Conidigenous cells all or mostly discrete, polyblastic, conida dry, catenate …………..Periconia

89. Conidiophores micronematous or semi-macronematous …………………………90
89'. Conidiophores macronematous ………………………96

90. Conidia solitary ………………………...91
90'. Conidia catenate with 2 or more transverse septa……………………………………..92
91. Conidia simple, not branched, appended or forked……………………………………..…92
91'. Conidia branched, cheirioid, multisep tame, muriform, olive to brown ………….Dictyosporium
92. Conidia transversely septate not helicoid on short branches ……………………………93
92'. Conidia muriform……………………………94

93. Conidia not produced on sporodochia… ……………………………….Trichocladium
93'. Conidia filiform, 9-13 (-19)-septate, end cells with cytoplasm ……………………Anguilluspora
93''. Conidia produced on sporodochia, conidia obpyriform, 1-2-septate, not constricted at the septa ……………………Bactrodesmium

94. Forming convoluted sporodochia…Epicoccum
94'. Not forming sporodochia…………………95

95. Conidia flattened with rows of cells radiating fanwise from the hilum …………Mycoenterolobium
95'. Conidia not flattened…………………..Monodictys

96. Conidigenous cells mostly determinate or percurrent ………………………………97
96'. Conidigenous cells sympodial or denticulate ………………………………………105

97. Conidigenous cells monoblastic, sympodial……………………………………………98
97'. Conidigenous polyblastic or intercalary if monoblastic……………………………………103

98. Conidia twisted or helicoid, colored, acrogenous, rarely straight, ¼ to 1 time contorted, 2-7 septate strongly constricted at the septa, colored, cells increasing in dia and pigmentation from base to apex ……109
98'. Conidia different, colorless if twisted………99

99. Conidiophores mostly unbranched………100
99'. Conidiophores branched………..Brachisporiella

100. Conidiophores not thin walled and collapsing or calyciform at the apex, conidia filamentous, some cells distoseptate …………………Ellisembia
100'. Conidia filamentous, usual sepa ……………………………Sporidesmium
100''. Conidiophores thin-walled & collapsing or calyciform at the apex………………...101

101. Conidiophores often with a cup at the apex, conidia frequently with cells unequally colored & dark bands at the septa……………Endophragmia
101'. Tip of conidiophores swollen, rounded, thin-walled, conidia spathulate, transversely septate…102
102. Conidia coiled in 3 planes to form ellipsoidal or cylindrical spore body……………...Helicoon
102’. Conidia coiled in 1 plane ……………………………..Helicoma/Helicomyces

103. Conidia commonly sigmoied, 3-septate ………………………..………………… Nakateae
103’. Conidia otherwise…………….104

104. Conidia with denticles neither thread-like nor cut-off by septa to form separating cells, conidia synnematous………………..Phaeiosaria
104’. Conidia with denticles thread-like or cut-off by septa to form separating cells, conidiophores smooth, sometimes with sterile setiform branches……………………….Hansfordia

105. Cells in conidia equal width along the coil, ………………………………….. Zalerion
105’. Cells variable in width along the coil……………………………………………… 106

106. Apical cell the largest in the coil, apical cell septation inconspicuous ……………..107
106’. Apical cells variable in width……………..109

107. Mature condia black, shiny, fist-shaped, not constricted at the observed septa…………..Hydea
107’ Apical cell shape different…………..108

108. Mature condia brown, all septa distinctly visible, constricted at the septa, helicoid, cells increasing pigmentation from the base to the apex…………………………….. Matusporium
108’. Apical cells inceasing in length and septation is conspicuous…………………. Cirrenalia

109. Conidiophores not denticulate………………110
109’ Conidia 15-65 × 14-56 µm, cells less than 10 µm wide, spirally contorted into a ball of up to 100 cells ……………………….. Halenospora

110. Conidiophores initially a spiral/coil, cells over 10 µm wide, forming a ball of cells by division in several planes …………………………….. Cumulospora
110’. Conidia different…………………………..111

111. Conidia with tetraradiate arms…………..112
111’ Conidia irregularly staurosporous, branched. septate, hyaline ………………… Varicosporina

112. Conidia unicellular but aggregated into groups up to 20………………………... Asteromyces
112’. Basal cell of conidia is small, light brown, 6-20 µm…………………………..Clavatospora

113. Conidiogenous cells tretic………………..114
113’. Conidiogenous cells phialidic………………115

114. Conidiogenous cells polytretic determinate, Conidiophores with terminal and intercalary nodose swellings…………………… Dendrophyilla
114’. Conidiogenous cells polytretic sympodial, Conidiophores not nodose, conidia with both longitudinal and transverse septa, catenate, obclavate…………………… Alternaria

115. Conidiogenous cells almost always monophialidic……………………………..116
115’. Conidiogenous cells mostly polyphialidic……………………………………………… 119

116. Conidia all endogenous becoming extruded, setae when present capitates, condia cylindrical or oblong, septate……………… Sporoschisma
116’. Conidia semi-endogenous or acrogenous……………………………………………… 117

117. Conidiogenous cells discrete………………118
117’. Phialides not in verticillis, mostly recurved at the tip, conidiophores usually sterile at tips & often setiform, conidia often curved with a setule………………………… Menispora

118. Conidia in verticillis, phialides forming a more or less complex head at the apex, …………………………… Stachybotrys
118’. Conidial phialides cylindrical, rounded at the apex, each with a minute opening and no collarattte……………… Stachylidium
118’. Phialides ampulliform or lageniform, often with distinct collarattte……………… Verticillium

119. Phialides born on penicilliate conidiophores, conidia variously coloured………… Penicillium
119’. Phialides on a terminal ampulla, conidia brown …………………………… Aspergillus

120. Hyphae produce rings and adhesive networks………………………… Arthrobotrys
120’. Hyphae produces adhesive knobs or non-constricting rings………………… Dactylellina

121. Conidium in an acervulus, ………... Cytospora
121’. Conidioma pycnidial………………………….. 122

122. Conidia septate……………………………..123
122’. Conidia aseptate…………………………….. 125

123. Conidia 3-7-septate, with appendages ……………………………. Stagonospora
Conidia with appendages ........................ 124
Conidia with diameter less than 2 µm, ........................................ Rhabdospora
Conidiogenesis holoblastic, conidia with diameter more than 3µm, ................ Robillarda
Conidiogenous cells blastic……………Alveophoma
Conidiogenous cells phialidic……………126

Conidiomata may be pycnidial on natural substrata but often stromatic in culture; Conidia of 2 different types alpha and beta conidia in addition to chlamydospores are found………… Phomopsis
On various substrata, pycnidia flask-shaped superficial or submerged, conidiogenous cells phialidic........ Phoma and Macrophoma species
Conidiogenous cells phialoconidiogenous; conidia produced endogenously inside phialides ........................................ Phialophorophoma

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