

CHECKLIST OF FRESHWATER MITOSPORIC FUNGI FROM MAHARASHTRA

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ABSTRACT

The present paper deals with substratum range of 133 species (Table 1) of freshwater Mitosporic fungi (130 Hyphomycetes and 3 Coelomycetes) reported so far from freshwater habitats of Maharashtra (India). They were found as saprophytes on woody debris and leaf litter submerged in freshwater environment. Most of the fungi encountered in the form of asexual stage (conidia) in foam samples. This checklist of freshwater Mitosporic fungi recorded from Maharashtra is compiled on the basis of present studies and previous published literature. The most frequently collected species of the genera are *Campylospora*, *Canalisporium*, *Dictyosporium*, *Flabellospora*, *Helicomyces*, *Trichocladium*, and *Tricladium*. The checklist includes detail of the substrata on which they encountered. This data will be useful in the compilation of freshwater fungal biodiversity of India.

INTRODUCTION

In total, 321 hyphomycetes have been reported from freshwater habitats in India by Borse et al. (2016, 2017). Goh and Hyde (1996) divided the FWH into four biological groups, i.e. aero-aquatic hyphomycetes, aquatic or Ingoldian hyphomycetes, submerged aquatic-hyphomycetes, and terrestrial-aquatic hyphomycetes. Investigations on Ingoldian hyphomycetes in India were mostly carried out in the twentieth century, with few studies after 2000, as research focused on submerged-aquatic hyphomycetes (Patil and Borse, 2015a). Freshwater Coelomycetes (pycnidial or acervular fungi) found in freshwater are not well documented (Goh and Hyde, 1996). These fungi occur on stream-side plants or on submerged wood litter (Thomas, 1996). Sati and Tiwari (1993) described a new species, namely *Pestalotiopsis submersus* on submerged leaf litter from India.

MATERIALS AND METHODS

Samples of foam, submerge leaves and woody debris were collected from various localities along rivers as well as water reservoirs (dams, lakes) and analysis was done by the following methods-

1) Wood analysis

Samples of submerged woody debris were collected, placed in polythene bags and transported to the laboratory. Samples contaminated by sediments or fouling organisms were washed with tap water. They were observed for sporulating structures. After initial

observations, samples were incubated in sterile plastic boxes containing layer of sterile sand moistened with sterile freshwater and after two weeks examined for the presence of fungal fruiting bodies. All samples were examined periodically and remoistened when necessary. Semi permanent slides of fungi isolated were made for further observations. Distil water was added as if necessary to prevent the substratum from drying out. Plastic boxes tied with rubber bands and placed in polythene bags to conserve a humid atmosphere. A few Naphthalene balls were placed in suitable container inside of plastic box, to kill any insect present in the wood samples.

2) Leaf litter analysis

Submerged leaves of different kinds were collected randomly from sampling sites and brought to the laboratory in moist polythene bags. They were washed several times in tap water and finally in distilled water. They were cut into small bits and incubated in separate Petri dishes containing distil water at laboratory temperature (25⁰ - 30⁰c). The water was replaced in Petri dishes once in three days to minimize the growth of bacteria and other organisms. The leaf bits were screened under microscope at 48 hours intervals for 60 days to detect the water-borne fungi appearing on them.

3) Foam analysis

In freshwater habitats, foam is formed by the movement of the water against natural barriers like stones, logs, twigs, especially in lotic habitats, constitutes a natural

trap for the conidia of Mitosporic fungi. Foam samples were collected in clean wide mouthed plastic bottles and kept for 24 hours to enable the foam to dissolve. It was preserved by adding FAA (Formaldehyde + Acetic acid

+ Alcohol) to yield 5% foam solution. Then samples were brought to laboratory and scanned under low power or high power of a microscope using 15 x eyepieces for the presence of conidia of Mitosporic fungi.

Table 1: Checklist of Freshwater Mitosporic Fungi from Maharashtra.

S. N.	Freshater Hyphomycetes	Substrate / source	Reference
1	<i>Actinosporella megalospora</i> (Ingold) Descals & Marvanova, = <i>Actinospora megalospora</i> Ingold	Conidia in foam samples	Patil, 2003a
2	<i>Alatospora acuminata</i> Ingold	Conidia in foam samples	Patil, 1998a, 2003a
3	<i>Anguillospora crassa</i> Ingold	On submerged leaves	Thakur, 1977
4	<i>Anguillospora longissima</i> (Sacc. & P. Syd.) Ingold = <i>Fusarium longissimum</i> (de Wild.,) Sacc. & P. Syd. = <i>Fusarium elongatum</i> de Wild.	On submerged leaves	Thakur, 1977
5	<i>Aquaphila albicans</i> Goh, K.D. Hyde & W.H. Ho	On submerged wood	Patil et al. 2015 a
6	<i>Arborispora palma</i> K. Ando	Conidia in foam samples	Borse et al. 2015a
7	<i>Articulospora tetracladia</i> Ingold = <i>Articulospora angulata</i> Tubaki	On damp bamboo	Patil & Rao, 1972
8	<i>Aureobasidium indicum</i> Pande & Ghate	From paper facto. effluent	Pande & Ghate, 1985
9	<i>Bactrodesmium aquaticum</i> B.D. Borse et al.	On submerged wood	Borse et al. 2019c
10	<i>Beltrania rhombica</i> O. Penz.	Conidia in foam samples	Patil, 2000, 2003b
11	<i>Brachiosphaera tropicalis</i> Nawawi	Conidia in foam as <i>Actinospora megalospora</i>	Patil & Kapadnis, 1979
12	<i>Brachydesmiella caudata</i> G.V. Rao & de Hoog	Conidia in foam samples	Patil et al. 2014a
13	<i>Camposporidium cristatum</i> Nawawi & Kuthub.	Conidia in foam samples	Patil et al. 2012
14	<i>Camposporium antennatum</i> Harkn.	Conidia in foam samples	Patil et al. 2015b
15	<i>Camposporium pellucidum</i> (Grove) S. Hughes = <i>Bactrodesmium caulicola</i> var. <i>pellucidum</i> Grove	Conidia in foam samples	Patil, 1998a, 2003b
16	<i>Campylospora chaetoclada</i> Ranzoni	Conidia in foam samples	Borse & Patil, 2006
17	<i>Campylospora filicladia</i> Nawawi	Conidia in foam samples	Shinde & Pawar, 2008
18	<i>Campylospora leptosoma</i> Marvanova & Laichmanova	Conidia in foam samples	Patil & Borse, 2015b
19	<i>Canalisporium caribense</i> (Hol.-Jech. & Mercado.) Nawawi & Kuthub.	On submerged wood	Patil et al. 2014b
20	<i>Canalisporium exiguum</i> Goh & K.D. Hyde	On submerged wood	Borse et al. 2008
21	<i>Canalisporium pallidum</i> Goh, W.H. Ho & K.D. Hyde	On submerged wood	Patil et al. 2014b
22	<i>C. pulchrum</i> (Hol.-Jech. & Mercado) Nawawi & Kuthub. = <i>Berkeasium pulchrum</i> Hol.-Jech. & Mercado	On submerged wood	Borse et al. 2008
23	<i>Cancellidium applanatum</i> Tubaki	On submerged wood	Patil et al. 2015b
24	<i>Ceratosporium indica</i> V. Rao & Deo Rao	Conidia in foam (as <i>Ceratosporella deviata</i>)	Patil et al. 2015c
25	<i>Chaetendophragmia africana</i> (Piron.) B. Sutton & Hodges = <i>C. triangularia</i> Matsush. var. <i>africana</i> Piron.	Conidia in foam samples	Ghanwat & Reddy, 2011
26	<i>Cirrenalia indica</i> G.V. Rao & A.P. Reddy	On submerged leaves	Patil et al. 2015b
27	<i>Clavariana aquatica</i> Nawawi	Conidia in foam samples	Patil et al. 2015c
28	<i>Clavariopsis aquatica</i> De Wild.	Conidia in foam samples	Patil, 2003a, b
29	<i>Clavariopsis azlanii</i> Nawawi	Conidia in foam samples	Patil & Borse, 2011
30	<i>Clavatospora tentacula</i> Sv. Nilsson = <i>Heliscus tentaculus</i> Umphlett	Conidia in foam (<i>Heliscus tentaculus</i>)	Patil & Kapadnis, 1979
31	<i>Condylospora spumigena</i> Nawawi	Conidia in foam samples	Borse et al. 2015a
32	<i>Delortia palmicola</i> Pat.	On submerged wood	Patil et al., 2014b
33	<i>Dendrosporium lobatum</i> Plakidas & Edgerton	Conidia in foam samples	Borse et al. 2015a
34	<i>Dendrostilbella indica</i> Pande & Ghate	From paper facto. effluent	Pande & Ghate, 1985
35	<i>Dicranidion gracile</i> Matsush.	Conidia in foam samples	Borse et al. 2015a
36	<i>Dictyosporium cocophilum</i> Bat.	On submerged wood	Patil et al., 2012
37	<i>Dictyosporium digitatum</i> J.L. Chen, C.H. Hwang & Tzean	On submerged wood	Patil et al. 2014b
38	<i>Dictyosporium elegans</i> Corda	On submerged wood	Ghan. & Reddy, 2011

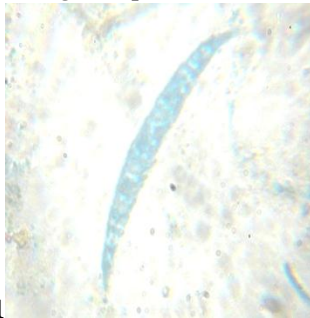
39	<i>Dictyosporium gaunti</i> Bhat & B. Sutton	On submerged wood	Patil et al. 2012
40	<i>Dictyosporium heptasporum</i> (Garov.) Damon = <i>Cattanea heptaspora</i> Garov. = <i>Speira heptaspora</i> Garov.	On submerged wood	Ghanwat & Reddy, 2011
41	<i>Dictyosporium tetraseriale</i> Goh et al.	On submerged wood	Patil et al. 2012
42	<i>Diplocladiella appendiculata</i> Nawawi	Conidia in foam samples	Gosavi & Borse, 2017
43	<i>Diplocladiella longibrachiata</i> Nawawi & Kuthub.	Conidia in foam samples	Patil et al. 2012
44	<i>Diplocladiella scalaroides</i> G. Arnaud ex M.B. Ellis	Conidia in foam samples	Borse & Patil, 2007
45	<i>Diplocladiella tricladioides</i> Nawawi	Conidia in foam samples	Patil et al. 2014a
46	<i>Dwayaangam dichomata</i> Nawawi	Conidia in foam samples	Borse & Patil, 2007
47	<i>Ellisembia adscendens</i> (Berk.) Subram. = <i>Sporidesmium adscendens</i> Berk. = <i>Clasterosporium adscendens</i> (Berk.) Sacc.	On submerged wood	Patil et al. 2015a
48	<i>Ellisembia repentioriunda</i> Goh & K.D. Hyde	On submerged wood	Patil et al. 2015a
49	<i>Endophragma microaquatica</i> (Tubaki) Matsush. = <i>Dactylella microaquatica</i> Tubaki, = <i>Monosporella microaquatica</i> (Tubaki) R.H. Petersen	On submerged leaves	Patil, 1998b
50	<i>Exserticlava triseptata</i> (Matsush.) S. Hughes = <i>Cordana triseptata</i> Matsushima	On submerged wood	Sridhar et al. 2010
51	<i>Filospora aquatica</i> Nawawi	Conidia in foam samples	Patil et al. 2014a
52	<i>Flabellocladia tetracladia</i> (Nawawi) Nawawi = <i>Flabellospora tetracladia</i> Nawawi	Conidia in foam samples	Shinde & Pawar, 2009
53	<i>Flabellospora acuminata</i> Descals & J. Webster	Conidia in foam samples	Pawara et al. 2009
54	<i>Flabellospora amphibian</i> (Price & Talbot) Descals = <i>Tetracrium amphibium</i> Price & Talbot	Conidia in foam samples	Pawara et al. 2011
55	<i>Flabellospora crassa</i> Alas.	Conidia in foam samples	Pawara et al. 2009
56	<i>Flabellospora multiradiata</i> Nawawi	Conidia in foam samples	Patil & Kapadnis, 1979
57	<i>Flabellospora octacladia</i> Saikia & A.K. Sarbhoy	Conidia in foam samples	Patil et al. 2014a
58	<i>Flabellospora verticillata</i> Alas.	Conidia in foam samples	Patil & Kapadnis, 1979
59	<i>Flagellospora curvula</i> Ingold	On subm. leaves	Patil et al., 2014a
60	<i>Flagellospora penicillioides</i> Ingold	Conidia in foam samples	Patil, 1998a, 2003b
61	<i>Gyoerffyella tricapillata</i> (Ingold) Marvanova = <i>Ingoldia tricapitata</i> Ingold	Conidia in foam samples	Patil & Kapadnis, 1979
62	<i>Helicoma polysporum</i> Morgan = <i>Helicosporium polysporum</i> (Morgan) Sacc.	On submerged leaf litter	Shinde & Pawar, 2009
63	<i>Helicomycetes colligatus</i> R.T. Moore	Conidia in foam samples	Patil et al. 2015d
64	<i>Helicomycetes lilliputeus</i> R.T. Moore	Isolated from submerged wood and bomboos	Jadhav & Borse, 2015
65	<i>Helicomycetes roseus</i> Link, ≡ <i>Helicomycetes albus</i> Preuss, ≡ <i>Helicomycetes elegans</i> Morgan, ≡ <i>Helicomycetes clarus</i> Morgan ≡ <i>Helicomycetes fuscopes</i> Linder	On submerged wood	Patil et al. 2015c
66	<i>Helicomycetes torquatus</i> L.C. Lane & Shearer	Conidia in foam samples	Borse et al. 2015b
67	<i>Helicosporium griseum</i> Berk. & M.A. Curtis = <i>H. lumbricoides</i> Sacc., = <i>H. cinereum</i> Peck	On submerged wood	Shinde & Pawar, 2009
68	<i>Helicosporium phragmitis</i> Honnel	On submerged leaves	Shinde & Pawar, 2008
69	<i>Hydrometrospora symmetrica</i> J. Gonczol & Revay	Conidia in foam samples	Patil et al. 2015d
70	<i>Intercalarispora nigra</i> J.L. Crane & Schokn.	On submerged wood	Patil et al. 2015c
71	<i>Isthmotricladia gombakiensis</i> Nawawi	Conidia in foam samples	Borse & Patil, 2006
72	<i>Isthmotricladia laeensis</i> Matsush.	Conidia in foam samples	Borse & Patil, 2007
73	<i>Iyengaria asymmetrica</i> Kuthub. & Nawawi	Conidia in foam samples	Patil et al. 2014a
74	<i>Koorchalomella oryzae</i> Chona et al.	On subm. <i>Fimbristylis</i> sp.	Talde, 1981
75	<i>Laridospora appendiculata</i> (Anastasiou) Nawawi = <i>Dactylella appendiculata</i> Anastasiou	On submerged leaves	Thakur, 1977
76	<i>Lateriramulosa uni-inflata</i> Matsush.	Conidia in foam samples	Patil & Kapadnis, 1979
77	<i>Lemonniera aquatica</i> De Wild.	On submerged leaves	Thakur, 1977
78	<i>Lunulospora cymbiformis</i> Miura	Conidia in foam samples	Gosavi & Borse 2017
79	<i>Magdalaena monogramma</i> G. Arnaud	Conidia in foam samples	Patil et al. 2014a

80	<i>Monodictys trichocladiopsis</i> Goh & K.D. Hyde	On submerged wood	Patil et al. 2015b
81	<i>Myceliophthora lutea</i> Cost. var. <i>macrospora</i> Pande & Ghate	Isolated from paper factory effluent	Pande & Ghate, 1985
82	<i>Neta angliae</i> K.D. Hyde & Goh	On submerged wood	Patil et al. 2015c
83	<i>Phaeoisaria clematidis</i> (Fuckel) S. Hughes	On submerged wood	Patil et al. 2015c
84	<i>Phaeoisaria sparsa</i> B. Sutton	From water on seed bait	Shinde & Pawar, 2009
85	<i>Phalangispora bharathensis</i> T.S.K. Prasad & Bhat	Conidia in foam samples	Patil et al. 2014a
86	<i>Phalangispora constricta</i> Nawawi & J. Webster	Conidia in foam samples	Patil, 2009
87	<i>Phalangispora nawawii</i> Kuthub.	Conidia in foam samples	Patil et al. 2015c
88	<i>Pleiochaeta setosa</i> (Kirchn.) S. Hughes = <i>Ceratophorum setosa</i> Kirchn.	Conidia in foam samples	Borse & Patil, 2015
89	<i>Retiarius bovicornutus</i> D.L. Olivier	Conidia in foam samples	Borse & Patil, 2015
90	<i>Rhexoacrodictys erecta</i> (Ellis & Everh.) W.A. Baker & Morgan-Jones	On submerged wood	Patil et al. 2015b
91	<i>Scolecobasidium variable</i> G.L. Barron & L.V. Busch	On submerged leaves	Shinde & Pawar, 2008
92	<i>Scutisporus brunneus</i> K. Ando & Tubaki	Conidia in foam samples	Patil et al. 2014a
93	<i>Setosynnema limnetica</i> B.D.Borse et al.	On submerged leaes of Mango and Eucalyptus sp	Borse et al. 2019b
94	<i>Spadicoides cordanoides</i> Goh & K.D. Hyde	On submerged wood	Patil et al. 2015c
95	<i>Speiropsis hyalospora</i> Subram. & Lodha	Conidia in foam samples	Patil & Kapadnis, 1979
96	<i>Speiropsis pedatospora</i> Tubaki	Conidia in foam samples	Patil & Kapadnis, 1979
97	<i>Speiropsis scopiformis</i> Kuthub. & Nawawi	Conidia in foam samples	Borse and Patil, 2015
98	<i>Sporoschisma saccadoi</i> E.W. Mason & S. Hughes	On submerged wood	Patil et al. 2014b
99	<i>Sporoschisma uniseptatum</i> Bhat & W.B. Kendrick	On submerged wood	Patil et al. 2014b
100	<i>Stachylidium bicolor</i> Link	On submerged wood	Shinde & Pawar, 2008
101	<i>Subulispora procurvata</i> Tubaki	Conidia in foam samples	Borse & Patil, 2015a
102	<i>Tetrachaetum elegans</i> Ingold	On sub. leaves	Patil, 2003a, b
103	<i>Tetracladium marchalianum</i> De Wild. = <i>Cerasterias raphidiodes</i> var. <i>inequale</i> Reinsch	Conidia in foam samples	Patil & Kapadnis, 1979
104	<i>Tetracladium setigerum</i> (Grove) Ingold	On submerged leaves	Thakur, 1977
105	<i>Tetraploa aristata</i> Berk. & Broome	Conidia in foam samples	Patil, 2003a
106	<i>Triadelphia diversa</i> Tzean & J.L. Chen	On submerged wood	Patil & Borse, 2015c
107	<i>Triadelphiain inquinans</i> (Sacc.) S. Hughes & Piroz. = <i>Dicoccum inquinans</i> Sacc.	On submerged wood	Patil & Borse, 2015c
108	<i>Triadelphia uniseptata</i> (Berk. & Broome) P.M. Kirk = <i>Dicoccum uniseptatum</i> (Berk. & Br.) Sacc.	On submerged wood	Patil & Borse, 2015c
109	<i>Trichocladium angelicum</i> Roldon & Honrubia	On submerged wood	Patil, 2012
110	<i>Trichocladium englandense</i> K.D. Hyde & Goh	On submerged wood	Patil, 2012
111	<i>Trichocladium lignicola</i> I. Schmidt	On submerged wood	Patil, 2012
112	<i>Trichocladium taiwanense</i> Matsush.	On submerged wood	Patil, 2012
113	<i>Tricladium aciculam</i> Nawawi	Conidia in foam samples	Borse et al. 2015b
114	<i>Tricladium angulatum</i> Ingold	Conidia in foam samples	Patil & Kapadnis, 1979
115	<i>Tricladium chaetocladium</i> Ingold	Conidia in foam samples	Borse et al. 2015b
116	<i>Tricladium minutum</i> (S.H. Iqbal) Marvanova & Descals, = <i>Scorpiosporium minutum</i> S.H. Iqbal	Conidia in foam samples	Borse et al. 2015b
117	<i>Tricladium splendens</i> Ingold	Conidia in foam samples	Patil & Kapadnis, 1979
118	<i>Tridentaria tyloata</i> Drechs.	Conidia in foam samples	Borse et al. 2015c
119	<i>Trinacrium robustum</i> Tzean & J.L. Chen	Conidia in foam samples	Borse et al. 2015c
120	<i>Trinacrium subtile</i> Fresen.	Conidia in foam samples	Borse & Patil, 2015
121	<i>Tripospermum limneticum</i> S.Y. Patil et al.	Submerged leaf of Mango	Patil et al. 2019
122	<i>Tripospermum myrti</i> (Lind) S. Hughes	Conidia in foam samples	Borse & Patil, 2015
123	<i>Triscelophorus acuminatus</i> Nawawi	Conidia in foam samples	Borse & Patil, 2006
124	<i>Triscelophorus konajensis</i> K.R. Sridhar & Kaver.	On submerged leaves	Patil, 2009
125	<i>Triscelophorus monosporus</i> Ingold	Conidia in foam samples	Patil & Kapadnis, 1979
126	<i>Varicosporium elodeae</i> W. Kegel	Conidia in foam samples	Borse & Patil, 2015
127	<i>Varicosporium scoparium</i> A. Roldon & Honrubia	Conidia in foam samples	Patil et al. 2011
128	<i>Wiesneriomyces laurinus</i> (Tassi) P. M. Kirk = <i>Wiesneriomyces javanicus</i> Koord.	On submerged leaves	Talde, 1983

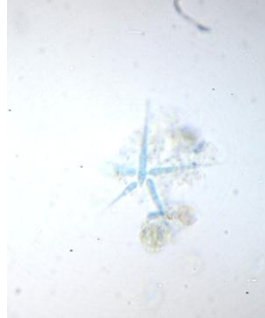
129	<i>Xylomyces elegans</i> Goh, W.H. Ho, K.D. Hyde & K.M. Tsui	Conidia in foam samples	Borse et al. 2014
130	<i>Xylomyces pucillus</i> Goh, W.H. Ho, K.D. Hyde & K.M. Tsui	On submerged wood	Borse et al. 2014
Freshwater: Coelomycetes			
131	<i>Chaetospermum carneum</i> Tassi, = <i>C. elasticae</i> , = <i>C. camelliae</i>	On stem of <i>Clitoraria buncea</i>	Talde, 1981
132	<i>Chaetospermum chaetosporum</i> (Pat.) A.L. Sm. & Ramsb.	On submerged twigs	Talde, 1981
133	<i>Chaetospermum indicum</i> Talde	On submerged stem of <i>Fimbristylis</i> sp	Talde, 1981

Plate I. Hyphomycetes, Conidia

1) *Anguillospora crassa*



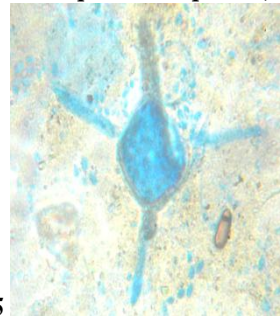
2) *Arborispora palma*,



3) *Articulospora tetracledia*



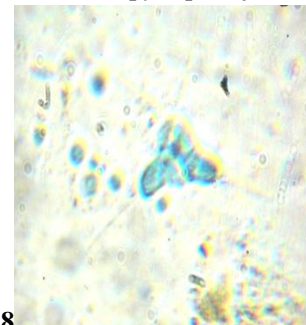
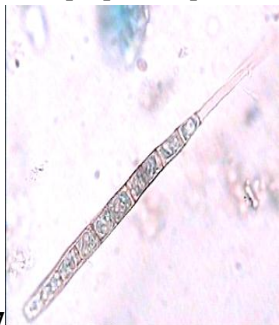
4) *Bactrodesmium aquaticum* 5) *Brachiosphaera tropicalis*, 6) *Camposporium antennatum*



7) *Camposporium pellucidum*

8) *Campylospora filicladia*

9) *Campylospora leptosome*.



10) *Canalisorium pallidum* 11) *Cancellidium applanatum* 12) *Chaetendophragma Africana*.

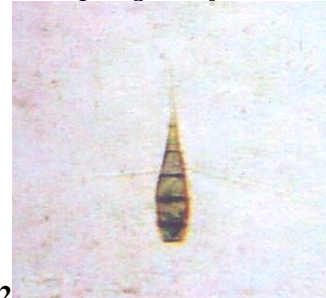
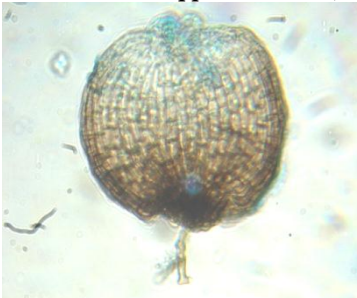
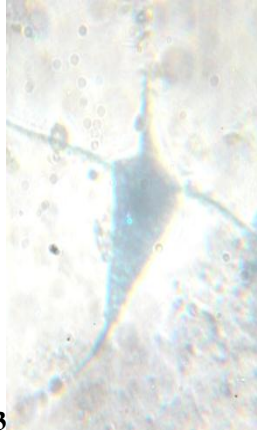


Plate 2: Hyphomycetes, Conidia

13) *Clavariana aquatica* 14) *Clavariopsis azlanii* 15) *Clavatospora tentacula*



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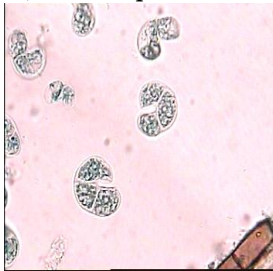


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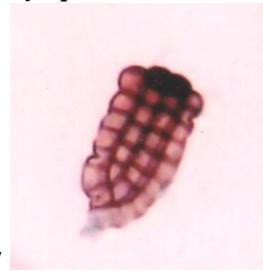


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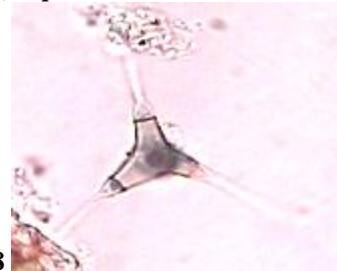
16) *Delortia palmicola* 17) *Dictyosporium tetraseriale* 18) *Diplocladiella tricladioides*



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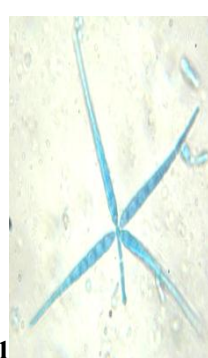


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19) *Dwayaangam dichomata* 20) *Flabellocladia tetracladia* 21) *Flabellospora multiradiata*



19



21



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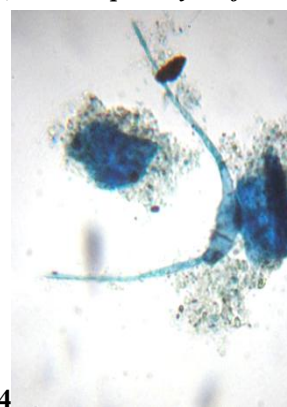
22) *Hydrometrospora symmetrica* 23) *Laridospora appendiculata* 24) *Lunulospora cymbiformis*



22

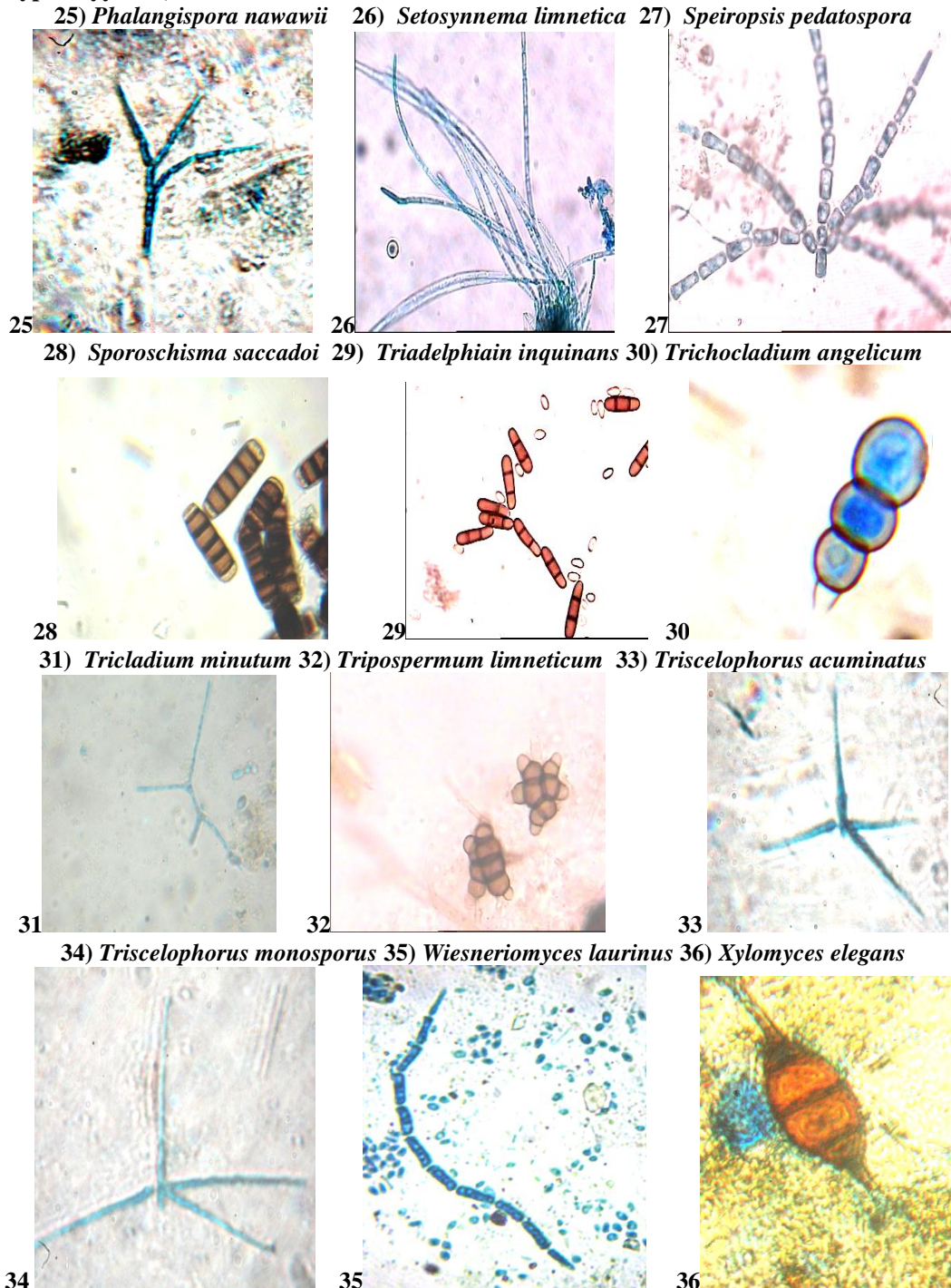


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Plate III. Hyphomycetes, Conidia.

**Comments**

According to Jones et al. (2014), there are 531 species of mitosporic fungi that had been recorded from freshwater habitats all over the world. In India, studies on freshwater mitosporic fungi (375 sp.) were compiled by Borse et al. (2016, 2017). In recent year, however, few new genera and species of freshwater Ascomycetes and Mitosporic fungi have been described from India (Borse et al. 2019 a-c; Borse & Pawar, 2019; Borse K N et al. a,b; Patil et al. 2019; Pawar et al. 2019). The present paper deals with substratum range of 133 species (Table 1) of freshwater Mitosporic funga (130 Hyphomycetes

and 3 Ceolomcetes) reported so far from freshwater habitats of Maharashtra (India).

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