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Aquatic fungi from Dang district (Gujarat, India)-III: Stream spora

[1] Ahire PK, [*2] Gosavi SA, [3] Borse BD
[1] Arts, Commerce & Science College, Pimpalner, Sakri, Dhule, Maharashtra, India
[2] Sathaye (Parle) College, Vile-Parle (East), Mumbai, Maharashtra, India
U.P. Arts & Science College, Dahiwel, Dhule, Maharashtra, India

Abstract
The present paper deals with twelve species of freshwater Hyphomycetes isolated from submerged leaves and from samples collected from Dang district of Gujarat state (India). All taxa are addition for the fungi of Gujarat state. The data provides information on the distribution of these fungi in India, apart from description and illustrations. This data will be useful in the compilation of aquatic fungal diversity of India.

Keywords: biodiversity, freshwater, hyphomycetes, submerged leaf, foam

1. Introduction
Fungi colonize, grow and multiply on a variety of substrates and habitats. They are the major players in the cycling of organic materials and energy around the world. They also play an important role in agriculture, biodegradation, bioremediation, food, medicine, pharmaceutical industries, waste management and other activities. Freshwater fungi grow and subsist on submerged and decaying plant litter in lotic or lentic waters and experts of freshwater fungi explore the streams, rivers and lakes for these fungi.
Previous studies on freshwater hyphomycetes from Gujarat state were made by Ahire *et al*. (2009) [1], Patil and Borse (2015) and Borse *et al*. (2015) [5]. The present paper deals with twelve species of freshwater Hyphomycetes isolated from submerged leaves and from samples from Dang district of Gujarat state (India). All taxa are in addition to the fungal flora of Gujarat state. The data provides information on the distribution of these fungi in India, apart from description and illustrations. Reports of fungi from Gujarat state were confirmed with the help of Bilgrami *et al*. (1979, 1981, 1991) [2, 3, 4], Jamaluddin *et al*. (2004) [7] and Borse *et al*. (2016) [6] and other relevant literature.

2. Material and Methods
Submerged Leaf Analysis- Submerge leaves of different kinds were collected from study area 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 separated in Petri dishes containing distill water at laboratory temperature (25 - 30^0c). 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 high-power using 10X or 15X eyepiece of microscope for 60 days to detect the aquatic fungi appearing on them.
Natural Foam Analysis- In general, the foam is a mass of bubbles of air or gas in a matrix of liquid film, especially an accumulation of fine, frothy bubbles formed in or on the surface of a liquid. 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 aquatic Hyphomycetes. Foam samples were collected at morning and evening time. Samples were placed in cleaned wide mouthed plastic bottles and kept for 24 hours to enable the foam to dissolve. It was prepared by adding FAA (5 ml. Formaldehyde + 90 ml of 70% Alcohol + 5 ml Acetic acid) to yield 5% foam solution. Then samples were brought to laboratory and scanned (by taking tiny drop of foam solution on glass slide) under low power or high power of a microscope using 10 x/15 x eyepiece for the presence of conidia of Hyphomycetes.

3. Taxonomic account
1) *Brachiosphaera tropicalis* Nawawi
In: Descals *et al*., *Trans. Br. Mycol. Soc.*, 67: 213 (1976).
Mature conidia consist of a spherical body, 46-58 µm diam, yellowish brown and furnished with 4-7 radiating arms, 100-170 µm long, 9-10 µm wide at the widest point, tapering to 4-5 µm wide at the rounded apex, constricted to 3-5 µm at the point of origin and becoming 3-5 septate.
Habitat: Conidia in foam sample, Ambika River, Dang District, Gujarat, 16 October 2011, AFDD - 17, Leg. P. K. Ahire.
Distribution in India: Maharashtra and Karnataka (Borse *et al*. 2016) [6].

2) *Camposporidium cristatum* Nawawi & Kuthub.
Mycotaxon, 32: 163 (1988).
Conidia cylindrical, slightly tapered at the rounded apex, truncate at the base, 9-12-distoseptate, verruculose, olivaceous to olivaceous brown, 75-94 µm long, 9-10 µm at the widest part, 6-7 µm wide at the base, apical cell bearing 4-7 divergent, non-septate, hyaline to subhyaline appendages measuring up to 60 µm long x 1.5 µm wide.

Habitat: Conidia in foam sample, Pampa Sarover, Subir, Dang district, Gujarat, 20 September 2009, AFDD - 39, Leg. Mr. P. K. Ahire.
Distribution in India: Maharashtra (Borse *et al*. 2016) [6].

3) *Camposporium pellucidum* (Grove) S. Hughes
Mycol. Pap., 36: 9 (1951).
Conidia cylindrical, or more usually cylindric-fusoid, brown, 78-140 µm long, 7.5-12 µm wide, up to 16-septate, base truncate 3-4 µm wide, apex rounded or subulately elongated in to a long filiform septate appendage of 30-200 µm long and *ca*. 2-3 µm wide, often slightly curved.
Habitat: Conidia in foam sample, Pampa Sarover, Shabari-dham, Subir, Dang district, Gujarat, 11 September 2011, AFDD - 40, Leg. Mr. P. K. Ahire.
Distribution in India: Andhra Pradesh, Maharashtra, Karnataka and Uttarakhand (Borse *et al*. 2016) [6].

4) *Campylospora filicladia* Nawawi
Trans. Br. Mycol. Soc., 63: 603 (1974a).
Conidia: consists of two distinct halves: The proximal half is triangular, 4-celled, 6-7.5 µm high and 10-12 µm wide. The distal half is allantoid, 4-celled, 9-13 µm long and 3-4.5 µm wide. Viewed either from the top or from bottom, the conidium is more or less rectangular, 4-4.5 µm thick with a round or conical projections at each corner. The appendages arising from the end cells are lie along the long axis. The projection opposite the origin of each appendage is bigger and rounder. The two appendages at the top of the conidium are usually longer than the lateral appendages. They are always directed opposite each other and are more or less perpendicular to the lateral appendages. Surface view of the conidium always shows these two appendages to be in a crossed position.
Habitat: Conidia in foam sample, Gira River, Dang District, Gujarat, 27 November 2011, AFDD - 19, Leg. P. K. Ahire.
Distribution in India: Karnataka, Kerala, Maharashtra and Tamil Nadu (Borse *et al*. 2016) [6].

5) *Clavatospora tentacula* Sv. Nilsson
Symb. Bot. Upsal., 18: 89 (1964).
Conidia hyaline, tetraradiate; main axis clavate, elongate, 0-6 septate, 30-75 µm long, 1.5-2.5 µm wide at base, 4-7 µm wide at apex; with 3 equidistant, divergent, 30-55 x 1-2.5 µm, appendages arising from apex and unconstricted at base.
Habitat: Conidia in foam sample, Ambika River, Dang District, Gujarat, 16 October 2011, AFDD - 20, Leg. P. K. Ahire.
Distribution in India: Maharashtra, Uttarakhand, Karnataka, Kerala and Andhra Pradesh (Borse *et al*. 2016) [6].

6) *Flagellospora penicillioides* Ingold
Trans. Br. Mycol. Soc., 27: 44 (1944).
Mycelium branched, septate, on malt agar hyaline at first, later bright brown with moniliform chains of inflated, oil-containing brown cells (chlamydospores), 15-35 µm long, 8-16 µm broad, occurring in the older parts of the aerial mycelium. *Aquatic conidiophores*: hyaline, branched as in *Penicillium*; unbranched stalk part 150-300 µm long, 2.5 µm broad; apical Phialides 8-40 in number, 15-25 µm long, 2.5 µm broad. *Conidia*: phialospores, hyaline, 45-55 µm long, 2.5 µm broad, in the tapering to 1.5 µm at the ends, unicellular or uniseptate, curved or more usually slightly sigmoid, produced in basipetal succession from the phialids. Aerial conidiophores, produced sparingly on malt agar, resemble the aquatic conidiophores but produce heads of slimy conidia.
Habitat: On submerged leaves, Gira River, Subir, 5 August 2012, AFDD – 28a; Conidia in foam sample, Dadhod River, Dang District, Gujarat, 5 August 2012, AFDD – 28b, Leg. P. K. Ahire.
Distribution in India: Uttarakhand, Karnataka, Kerala, Andhra Pradesh and Maharashtra (Borse *et al*. 2016) [6].

7) *Jaculispora submersa* H.J. Huds. & Ingold
Trans. Br. Mycol. Soc., 43: 475 (1960).
Conidiua hyaline, unicellular, main axis straight, 35-55 µm long with truncate base, 3-3.5 µm wide at the base increasing to 5-7 µm wide at the distance of about 25-35 µm from the base, apex ending in a fine point, making the conidium appear dart-shaped except for three lateral appendages. *Appendages* three, hair-like, equally spaced around the circumference, arise at a level just beyond half way between the base and apex, 10-24 µm long and 0.5-1 µm wide.
Habitat: Conidia in foam sample. Ambika River, Dang District, Gujarat, 18 October 2009, AFDD - 31, Leg. P. K. Ahire.
Distribution in India: Andhra Pradesh, Uttarakhand, Karnataka and Maharashtra (Borse *et al*. 2016) [6].

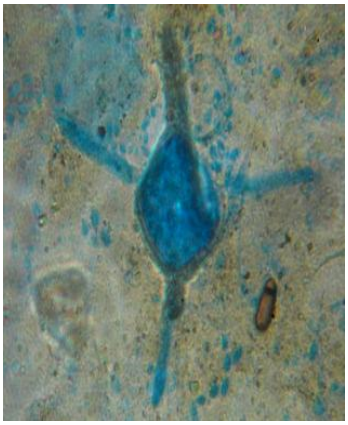
8) *Tetracladium marchalianum* De Wild.
Ann. Soc. Belge Microsc., 17: 39 (1893).
Mycelium: branched, septate. *Conidiophores*: sparingly branched often with two conidia at different stages of development. *Conidia*: aleuriospore, normally consisting of four divergent branches 20-40 µm long, 2-3 µm broad and of two more or less spherical knobs, 3-5 µm broad, one situated just above the point from which the four branches diverge, the other a short distance from this point on the upper side of one of the branches.
Habitat: Conidia in foam sample, Pampa Sarover, Dang district, Gujarat, 19 September 2010, AFDD - 33, Leg. Mr. P. K. Ahire.
Distribution in India: Uttarakhand, Maharashtra, Karnataka, Andhra Pradesh and Madhya Pradesh (Borse *et al*. 2016) [6].

9) *Tetracladium setigerum* (Grove) Ingold
Trans. Br. Mycol. Soc., 25: 371 (1942).
Conidia consisting of four divergent arms 20-40 µm long, each tapering from 3 µm near the central region of the spore to 1 µm near its tip, and of three elongated, parallel, finger-like processes, 12-15 µm long, 3-9 µm broad, two of which are inserted just above the point of divergence of the four arms and the third a short distance along one of the arms.
Habitat: Conidia in foam sample, Pampa Sarover, Subir, Dang district, Gujarat, 23 August 2009, AFDD - 34, Leg. Mr. P. K. Ahire.
Distribution in India: Uttarakhand, Maharashtra, Karnataka, Andhra Pradesh (Borse *et al*. 2016) [6].

10) *Lateriramulosa uni-inflata* Matsush.
"*Microfungi of the Solomon Islands and Papua-New Guinea* (Osaka)", pp. 34 (1971).
Conidia hyaline, 20-23 µm in diam., appear as small triangles, which consist of one main axis, 6.5-9 x 1.6-2 µm, and three branches measuring 7.5-10 x 3.5-4 µm; the lower two branches are composed of a swollen basal part and a spike-like seta. The upper arm has only one half of its base swollen.
Habitat: Conidia in foam sample, Purna River, Dang District, Gujarat, 28 October 2012, AFDD - 51, Leg. P. K. Ahire.
Distribution in India: Maharashtra, Karnataka, Kerala, Tamil Nadu and Andhra Pradesh (Borse *et al*. 2016) [6].

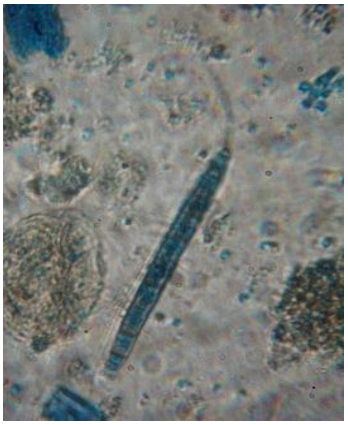
11) *Phalangispora nawawii* Kuthub.
Trans. Br. Mycol. Soc., 89: 419 (1987).
Conidial chains yellowish-brown, consists of 13-19 cells connected by narrow isthmi, with main axis and 2-3 laterals, 6-8 cells in main axis, 2-6 cells in lateral branches, 65-90 µm from base to apex, lateral branches 23-70 µm, basal cells conical and 8-9 x 2 µm, apical cells conical and 8-12 x 2 µm, cells along conical chain cylindrical and 10-12 x 1.5- 2 µm, light brown.
Habitat: Conidia in foam samples, Gira River, Dang district, Gujarat, 6 November 2011, AFDD - 53, Leg. Mr. P. K. Ahire.
Distribution in India: Karnataka, Uttarakhand, Madhya Pradesh and Maharashtra (Borse *et al*. 2016) [6].

12) *Xylomyces elegans* Goh, W.H. Ho, K.D. Hyde & K.M. Tsui
Mycol. Res., 101: 1324 (1997).
Chlamydospores 66-104 x 26-40 µm, broadly fusiform, straight or rarely slightly curved, with 4-6 thick septa, distinctly constricted at the septa, the two central cells greatly enlarged, guttulate, thick-walled, smooth, yellowish brown to orange brown, uniform in colour or sometimes end cells paler.
Habitat: Conidia in foam samples, Khapari River, Dang district, Gujarat, 22 August 2010, AFDD - 61, Leg. Mr. P. K. Ahire.
Distribution in India: Maharashtra (Borse *et al*. 2016).

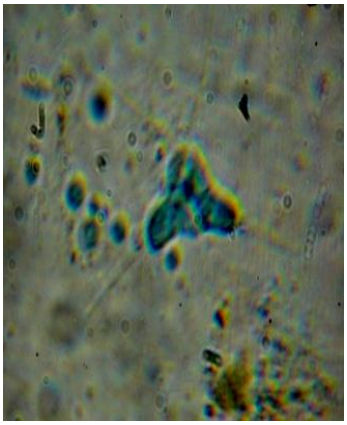


1. *Brachiosphaera tropicalis*

2. *Camposporidium cristatum*

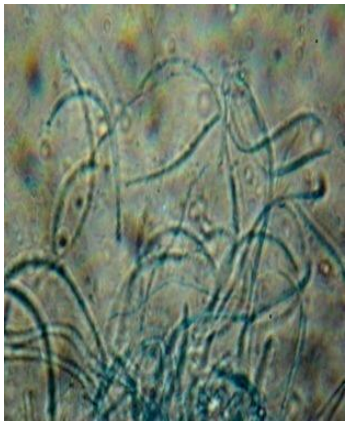


3. *Camposporium pellucidum*,



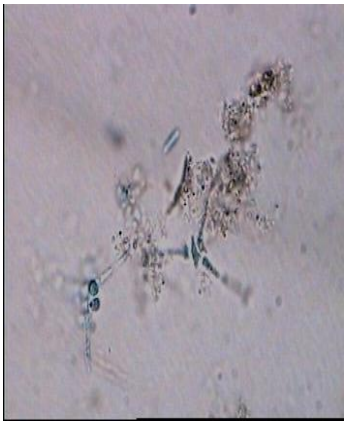
4. *Campylospora filicladia*

5. *Clavatospora tentacula*

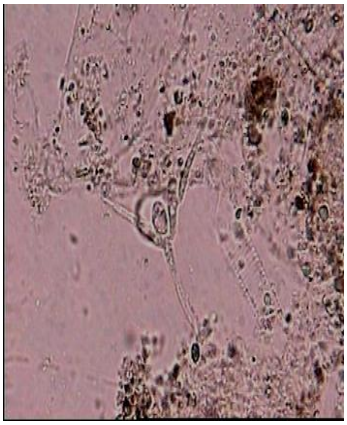


6. *Flagellospora penicillioides*,

7. *Jaculispora submerse*



8. *Tetracladium marchalianum*


9. *Tetracladium setigerum*,


10. *Lateriramulosa uni-inflata*


11. *Phalangispora nawawii*


12. *Xylomyces elegans*

Fig 1: (1-12) Conidium / Conidia / Chlamydospores

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