JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Freshwater Hyphomycetes Fungi from Tapi District (Gujarat, India)

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Abstract: The present work reports the occurrence of twelve Hyphomycetes species spread in nine genera viz Anguillospora Ingold (2), Angulospora Sv. Nilsson (1)**,** Brachiosphaera Nawawi (1), Campylospora Ranzoni (2), Clavariana Nawawi (1), Filosporella Nawawi (1)**,** Flabellospora Alas (1), Triscelophorus Ingold (2), Varicosporium W. Kegel (1). All these specimens are collected from Tapi river, Purna river, Nesu river, Mindhola river, Ambica river, Gira river and Doswada dam in Tapi district, Gujrat.

The data provides information on the range of distribution of these fungi in India. Descriptions and illustrations are provided.

IndexTerms **- Freshwater hyphomycetes, foam sample, Leaf litter, Conidia, Tapi river.**

I. INTRODUCTION

Hyphomycetes fungi are ecologically important as decomposers of organic matter in freshwater ecosystems, particularly of leaf litter. They play an important role in nutrient cycling and energy transfer to stream food webs by breaking down complex plant tissues into simpler forms of food, useful for zooplanktons.
Hyphomycetes are known as imperfect fungi. They reproduce asexually through the formation of conidia. Shape of conidia is highly diverse, ranging from simple shapes like spherical, subspherical, and ellipsoidal to more complex forms such as fusiform, pyriform, clavate, sickle-shaped (sigmoid), helical and tetraradiate. These shapes vary by species and can also differ based on the specific environment. Aquatic hyphomycetes are known for specialized, often three-dimensional forms like tetraradiate and sigmoid spores that aid in dispersal in water and adherence to substrates.

II. MATERIALS AND METHODS

Approximately 10 ml of foam formed due to the fast-flowing turbulent water at the study area was collected in plastic bottles and kept for 24 hours to enable the foam to subside. It was fixed in FAA to yield 5 % foam solution at the collection spot or fixed in FAA taking 4 ml foam solution and 1 ml FAA. The samples were brought to the laboratory and examined under a high-power research microscope with lactophenol stain to detect the conidia.

III.TAXONOMIC ACCOUNT

3.1 Anguillospora crassa Ingold (Fig. 1)
Trans. Br. Mycol. Soc., 41: 367 (1958).
Conidia - Hyaline, vermiform more or less L- or S-shaped, 5-10 septate, 120-200 µm long and 15-20 µm broad in the middle, tapering to 8- 10 µm toward the ends. Some conidia are with dilations at septa.
Material examined - Conidia in foam sample, Tapi river (at Kukurmunda); V. S. Patil, 15 August 2013. Conidia in foam Samples, Purna river (at Hindola); V. S. Patil, 09 August 2014.
Distribution in India – KK: On submerged leaves (Sridhar and Keveriappa, 1984a); UK - On submerged leaves and conidia in foam samples (Mer and Sati, 1989); GJ - conidia in foam samples (Ahire et al., 2009).
Remarks - The measurements and description of conidia agreed with that of A. crass Ingold (1958). Therefore, it is assigned to that species.

3.2 Anguillospora gigantea Ranzoni (Fig. 2)
Trans. Farlowia, 4: 362 (1953)
Conidia - Hyaline, curved, sigmoid, segmented, 350- 750 µm long and 5-7 µm broad in the middle, tapering both ends. 7-11septate. It is the largest species of the genus Angiullospora.

Material examined - Conidia in foam samples, Doswada Dam (at Rampura); V. S. Patil, 03April 2012.
Distribution in India – KK- Conidia in foam samples (Ramesh, 2002).
Remark - The measurements and description of conidia agreed with that of A. gigantea Ranzoni (1953). Therefore, it is assigned to that species. This is reported for the first time in Gujarat.

3.3 Angulospora aquatica Sv. Nilsson (Fig.3) Sv. Bot. Tidskr., 56: 354 (1962).
Conidia - conidia produced laterally or from the tip of the conidiophores, hyaline, unicellular, 75-100 µm long, 1.5-2 µm broad, tapering to 1 µm broad at the apex. Conidia are of various shapes but typically they are in the form of an open question mark, curved or sigmoid, mostly with right and sharp angles and usually in more than one plane.
Material examined - Conidia in foam sample, Tapi river (at Mahupada); V. S. Patil, 15 August 2013.
Distribution in India - KK- On submerged leaves (Rajashekhar and Kaveriappa, 1992); GJ- Conidia in foam samples (Borse et al., 2015b).
Remark - The measurements and description of conidia agreed with that of A. aquatica Nilsson (1962). Therefore, it is assigned to that species.

3.4 Brachiosphaera tropicalis Nawawi In: Descals et al. (Fig. 4)
Trans. Br. Mycol. Soc., 67: 213 (1976).
Conidia - large, globose, subhyaline, central sphere bearing 4-6 long radiating arms, bases sub constricted are readily recognized. The mature conidia consist of a spherical body, 46-58 µm diameters and filled with many small spherical globules up to 6 µm diameter. Arms are 95-180 µm long, 9-11 µm wide at the widest point, tapering to 4-5 µm wide at the rounded apex, constricted to 3-5-septate.
Material examined - Conidia in foam sample, Purna river (at Bahej); V. S. Patil, 17 August 2013.
Distribution in India - MH - Conidia in foam samples (Patil and Kapadnis, 1979) KK- Conidia in foam (as Actinospora megalospora, Sridhar and Keveriappa, 1982a).
Remarks - The measurements and description of conidia agreed with that of B. tropicalis Nawawi (In: Descals et al., 1976). Therefore, it is assigned to that species. This is reported for the first time in Gujarat.

3,5 Campylospora chaetocladia Ranzoni (Fig. 5)
Farlowia, 4: 373 (1953).
Conidia - Hyaline, tetraradiate, composed of two parts proximal half is larger triangular to rhombic, 3-4-septate, 8-12 µm high, 10-12 µm wide at base, distal half allantoids, smaller, 3-4 celled, 9-13 µm long, 3.5-5 µm wide, each ending in one of the four slender appendage 30-40 µm long.
Material examined - Conidia in foam sample, Nesu river (at Narayanpur); V. S. Patil, 08August 2014. Conidia in foam sample, Tapi river (at Junai); V. S. Patil, 16 August 2013.
Distribution in India - UK:-Conidia in foam (Mer and Sati, 1989); KK- On submerged leaves, conidia in foam and water samples (Sridhar and Keveriappa, 1982a); KL- Conidia in foam (Sridhar and Keveriappa, 1985a); AP- On submerged leaves (Manoharachary and Madhusudan Rao, 1983); MS- Conidia in foam samples (Borse and Patil, 2006); GJ- Conidia in foam samples (Ahire et al., 2009); MP- On submerged leaves (Agarwal et al., 1992).
Remarks - The measurements and descriptions of conidia are agreed with that of C. chaetocladia Ranzoni (1953). Therefore, it is assigned to that species

3.6 Campylospora filicladia Nawawi (Fig. 6)
Trans. Br. Mycol. Soc., 63: 604 (1974).
Conidia - Hyaline tetraradiate, consist of two distinct halves. The proximal half is triangular, 4 celled, measuring 6-8 µm high and 10-12 µm wide. The distal half is allantoid, smaller, 4 celled and measures 9-13 µm long, 3-5 µm wide. The appendages arising from end cells. The appendages at the top of the conidium are usually longer (15-355 µm) than the lateral appendages (7-17 µm). Apical appendages are usually crossed and longer than the other two.
Material examined - Conidia in foam sample, Nesu river (at Vadpada); V. S. Patil, 08 August, 2014. Conidia in foam sample, Tapi river (at Junai); V. S. Patil, 16 August 2013.
Distribution in India – KK- Conidia in foam (Subramanian and Bhat, 1980); KL- Conidia in foam (Subramanian and Bhat, 1980); TN- Conidia in foam (Subramanian and Bhat, 1980); MH - On submerged leaves and conidia in foam (Shinde and Pawar, 2008).
Remarks - The description and measurement of conidia agreed with that of C. filicladia Nawawi (1974). Therefore, it is assigned to that species. This is reported for the first time in Gujarat.

3.7 Clavariana aquatica Nawawi (Fig.7) Trans. Brit. Mycol. Soc., 67: 217 (1976).
Conidia -tetra radiate, three diverging arms develop from its crown, forth arm develops through the detachment scar after release of conidium and more or less of the same length as the rest of the arms. Central body (triangular in outline), 5-8 µm wide at base, 24-33 µm wide above (crowned portion), three long thin appendages 53-160 µm long, 3-5 µm at widest point, tapering to 2-2.5 µm toward their end; appendages septate but not constricted at their origin. The central body becomes highly vacuolated at maturity.

Material examined - Conidia in foam sample, Ambika River (at Chunavada); V. S. Patil, 17 August 2013.
Distribution in India – UK- Conidia in foam (Mer and Sati, 1989); KK - Conidia in foam and water samples (Sridhar and Kaveriappa, 1982a); GJ - Conidia in foam and water samples (Borse et al., 2015b).
Remark - The present fungus was reported for the first time from Gujarat by Borse et al.(2015b**)**

3.8 Filosporella aquatica Nawawi (Fig. 8) Trans. Br. Mycol. Soc., 67: 173 (1976a)
Conidia - hyaline long, filiform and multiseptate, straight, 6-12 septate, 178-245 µm long, 4-5 µm widest their broadest point and taper slightly obtuse at the apex. Each cell of conidium consists of two or more guttules. Newly detached conidia have a truncate base but this eventually become cone or teat shaped.

Material examined - Conidia in foam sample, Gira river (at Dungarda); V. S. Patil, 05 October 2014.
Distribution in India – UK- conidia in foam samples (Sati et al., 2002);
Remarks - The description and measurement of conidia completely agreed with that of F. aquatica Nawawi (1976 a). Therefore, it is assigned to that species. This is an addition to the fungi of Gujarat

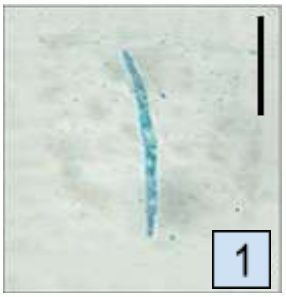
3.9 Flabellospora octacladia Saikia & A.K. Sarbhoy (Fig. 9) Indian Phytopath, 33: 459-461 (1980).
Conidia - form eight elegant arms, arise equidistantly around it. Arms are 2-3 of which are often shorter than the rest, hyaline, 3-5-septate, measuring 18-54 µm long, 6-9 µm broad at the middle across, tapering to 2- 3 µm at the apex.
Material examined - Conidia in foam sample, Tapi river (at Toranda); V. S. Patil, 16 August 2013.
Distribution in India - AS- On leaf litter in terrestrial habitats (Saikia and Sarbhoy, 1980); MH - conidia in foam sample (Patil et al., 2014a).
Remarks - The measurement and description of conidia agreed with that of F. octacladia (Saikia and Sarbhoy, 1980). Therefore, it is assigned to that species. This is reported for the first time in Gujarat.

3.10 Triscelophorus acuminatus Nawawi (Fig. 10)
Trans. Br. Mycol. Soc., 64: 346 (1975)
Conidia - thalloconidia, hyaline, smooth wall and thin, septate, tetraradiate, (main axis with three lateral branches), main axis is 44-66 µm long and 3.5-5 µm at the widest point, tapering gradually to about 0.5 µm at the apex, up to 8-septate, and not constricted at the septa. The arms are connected to the basal cell by a very narrow, thread-like isthmus. The successively formed arms are 21-54 x 3-4.5 µm. The arms broaden out after the attachment constriction and then taper gradually to the apex. In mature conidia the arms tend to be slightly shorter than the main axis. This is one of the most abundant species in foam samples.
Material examined - Conidia in foam samples, Mindhola river (at Jetvadi); V. S. Patil, 30 September 2013. Conidia in foam samples, Purna river (at Lakhali); V. S. Patil, 07 September 2014.
Distribution in India - UK-Conidia in foam samples (Mer and Sati, 1989); KK- On submerged leaves, conidia in foam and water samples (Sridhar and Kaveriappa, 1982a); KL- On submerged leaves, conidia in foam and water samples (Sridhar and Kaveriappa, 1985a); MH - Conidia in foam samples (Borse and Patil, 2006); GJ- Conidia in foam samples (Ahire et al., 2009); MP- On submerged leaves, twigs and conidia in foam samples (Agarwal et al., 1992).
Remarks - The measurements and descriptions of conidia are completely agreed with that of T. acuminatus Nawawi (1975b). Therefore, it is assigned to that species.

3.11 Triscelophorus konajensis - K.R. Sridhar & Kaver. (Fig.11) Indian Phytopath., 40: 102 (1987a).
Conidia - hyaline, terminal, septate, tetraradiate, (main axis with three lateral branches), main arm 20-35 µm long, 3.5-4 µm broad, 1-3 (rarely 4) septate; three secondary laterals, 15-30 µm long, 2-2.5 µm broad, 0-2 (rarely 3) septate.
Material examined - Conidia in foam samples Tapi river, (at Amalpada); V. S. Patil, 24 March 2012.
Distribution in India – KK -On submerged leaves, conidia in foam and water samples (Sridhar and Kaveriappa, 1987a); UK- On submerged leaves (Sati and Belwal, 2009); MH-Conidia in foam samples (Patil, 2009).
Remark - This is reported for the first time in Gujarat.

3.12 Varicosporium elodeae W. Kegel (Fig.12) Ber. Dtsch. Bot. Ges., 24: 213 (1906).
Conidia - conidia consisting of a main axis 60-100 µm long, 3 µm wide, with one to three laterals of the same width developed on one side only of the main axis. Each of these laterals may branch again usually in the same one-sided manner. The degree of branching of the spore varies considerably. Where each spore is joined to the conidiophore and at the point of origin of each branch of the spore, is a narrow constriction or isthus. The conidia may fragment to some extent by a part of the spore breaking off at an isthmus.
Material examined - Conidia in foam sample, Tapi river (at Jetvadi); V. S. Patil, 24 March 2013
Distribution in India – AS- On submerged leaves (Bhattacharya and Baruh, 1953); KK- conidia in foam samples (Sridhar and Kaverippa, 1984b); AP - conidia in water samples (Manoharachary and Galiah, 1987).
Remark - The present fungus is recorded for the first time in Gujarat.

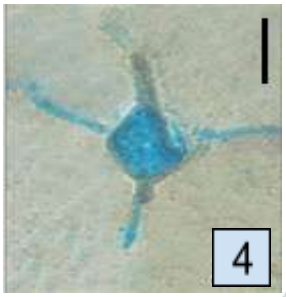
Photoplate



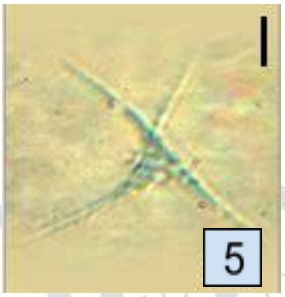
1. Anguillospora crass

2. Anguillospora gigantea

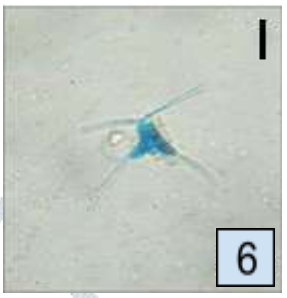
3. Angulospora aquatica



4. Brachiosphaera tropicalis

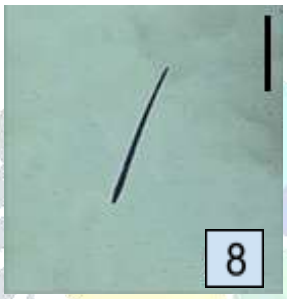


5. Campylospora chaetocladia

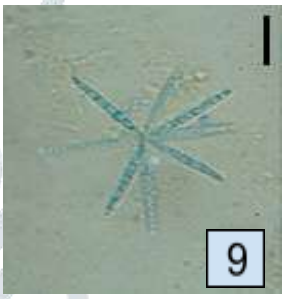


6. Campylospora filicladia

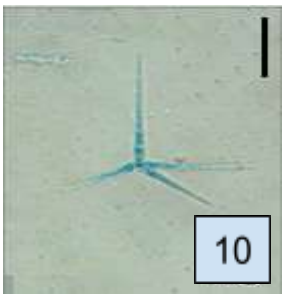
7. Clavariana aquatica



8. Filosporella aquatica

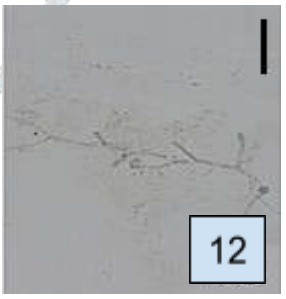


9. Flabellospora octacladia



10. Trisclelosporous acuminatus

11. Trisclelosporous konajensis



12. Varicosporium elodeae

IV. RESULT

The present finding shows 7 Hyphomycetes species of aquatic fungi, out of 12 species are new to Gujarat (India).

V. ACKNOWLEDGMENT

I am thankful to Dr. Angel Aguirre-Sanchez and authorities of Smithsonian Tropical Research Institute, Washington, DC, USA, for sending pdf files of rare research articles on aquatic fungi. I am thankful to Agar Agar Institute, Pune, for its beneficial use of library research material. I am also grateful to Prin. Dr. D.A. Patil and Mrs. Dr. Sandhya S. Patil (Head, P.G. Dept. of Botany), S.S.V.P. Sanstha's L.K. Dr. P. R. Ghogrey Science College, Dhule, Maharashtra for providing laboratory

Abbreviations

AP: Andhra Pradesh, AS: Assam, GJ: Gujarat, KK: Karnataka, KL: Kerala, MH: Maharashtra, MP: Madhya Pradesh, TN: Tamil nadu, UK: Uttarakhand, FAA: Formaldehyde, Fig.Figure, µm: micrometer.

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