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Original Research

Assemblage of aquatic hyphomycetes and their colonization of leaf litter in a tropical lateritic cave stream

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Abstract

Investigations on occurrence of aquatic hyphomycetes in lateritic cave streams in India are meager. This study examined the assemblage, diversity, and leaf litter colonization of aquatic hyphomycetes in a cave stream in southwest India. Physicochemical features of water samples, the occurrence of conidia in water, foam, colonization of aquatic hyphomycetes in naturally submerged leaf litter and introduced sterile leaf discs (banyan and cashew) were assessed during the post-monsoon season. Naturally submerged leaves were found to possess the highest species richness compared to water, foam and introduced leaf discs. The Shannon diversity was also the highest in naturally submerged leaf litter than other samples. Among the five samples assessed, three aquatic hyphomycetes, *Anguillospora longissima*, *Flagellospora curvula* and *Lunulospora curvula* were common in the top five species. *Helicomyces collegatus*, *Lunulospora cymbiformis*, *Phalangispora bharathensis*, *Synnematophora constricta*, *Tetracladium marchalianum* and *Trisulcosporium acerinum* are new records for southwest India. This study provides valuable insights on the occurrence and capability of colonization of leaf litter by aquatic hyphomycetes in artificial cave streams.

Keywords: Foam samples, Fungal conidia, Leaf litter, Species richness, Water chemistry

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Introduction

Fungi play an important role in the mineralization of organic matter, recycling, and energy flow in aquatic ecosystems. Aquatic hyphomycetes are dominant on the dead leaf litter in lotic habitats and serve as a major trophic link between leaf litter and stream invertebrates (Bärlocher and Sridhar 2014). Although they flourish well in lotic habitats, they have occupied other ecological niches, such as lentic habitats, terrestrial litter, and tree canopies (Chauvet et al. 2016, Sharathchandra and Sridhar 2020, Sridhar et al. 2020, Magyar et al. 2021, Sridhar 2024). We prefer the term "aquatic hyphomycetes" to distinguish them from other anamorphic or asexual fungi, despite their primary affiliation with ascomycetes.

Another interesting ecological niche for aquatic hyphomycetes is cave streams. The conditions that prevail in caves support the activities of several fungi (Kozlova and Mazina 2020). Fungi are transported into caves by different paths such as spores from soil, bats, birds, insects, and surface runoff) (Novákova 2009, Souza-Silva et al. 2012, Vanderwolf et al. 2013, Prous et al. 2015, Hendus et al. 2019, Kozlova and Mazina 2020, Preedanon et al. 2023). Low temperatures, darkness and surface area in cave streams attract insects, birds, and bats, which enhance the fungal activity. Algae, bryophytes, ferns, lichens, and mosses growing on the surface of the photic zone of cave streams supply organic detritus for fungal growth, establishing a gradient of fungal biota in different segments of the cave streams.

In the coastal region of southwestern India, indigenous water management has been practiced for over a century by the construction of horizontal channels (or caves) in the lateritic region up to 30−40 m (~1×2−2.5 m) along the lateritic hills, which leads to the extraction of groundwater by gravitation (Sharathchandra and Sridhar 2021). This traditional knowledge facilitated finding a perennial water source for drinking, domestic use, and irrigation. The common tree species along the cave streams include *Ficus virens*, *Macaranga indica* and *Vateria indica*. The presence of termite mounds

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confirms the availability of water sources and directions to construct tunnels. About 5,000 lateritic caves have been created in southwest India (Jayan 2012).

Aquatic hyphomycetes are present in streams, intermittent streams, estuaries, canopies, and terrestrial litters in the coastal terrain of southwest India (Sridhar and Kaveriappa 1988, Sridhar et al. 1992, Sridhar et al. 2013, Ghate and Sridhar 2015, Sharathchandra and Sridhar 2020, Sridhar et al. 2020). However, studies on the occurrence of fungi are meager in the cave streams of southwest India (Koilraj et al. 1999, Sharathchandra and Sridhar 2021). Thus, the aim of the present study is to follow the assemblage and diversity of aquatic hyphomycetes in water, foam, naturally deposited leaf litter and deliberately submerged leaf litter (banyan and cashew) in a cave stream in Nekkarekadu located on the southwest coast of India.

Materials and Methods

Study region and samples: The occurrence of aquatic hyphomycetes was assessed in a cave stream in Nekkarekadu located on the southwest coast of India (12.74°45′N, 75°5′E) (110 m asl) during the post-monsoon season (November–December, 2021). The cave stream is surrounded by scrub vegetation with a dominance of several tree species such as *Anacardium occidentale* (cashew), *Antiaris toxicaria* (Poison wood), *Calophyllum inophyllum* (Beach Calophyllum or Tamanu), *Ficus virens* (Sacred fig or White fig), *Haldina cordifolia* (Bamboose tree), *Hymenodictyon orixense* (Orixa), *Macaranga indica* (Indian Macaranga), *Soymida febrifuga* (Soymida), *Syzygium cumini* (Jamun or Java plum), *Tectona grandis* (Teak), *Terminalia alata* (Terminalia or Indian laurel) and *Vateria indica* (Indian Vateria). Air temperature and relative humidity (in the shade of a canopy) were measured during sampling (Mextech Digital Thermo Hygrometer M288CTHW, Mextech Technologies India Private Limited, Mumbai, Maharashtra, India).

A schematic flow chart of the protocol followed to assess aquatic hyphomycetes is presented in Fig. 1. Water samples were collected and filtered during sampling for the assessment of drift conidia. Similarly, foam accumulated in the cave stream was also collected. Naturally submerged leaf litter (from different plants) was piled and cut into 1.5 cm discs by cork-borer for bubble chamber incubation. Fallen cashew (*Anacardium occidentale*) and banyan (*Ficus benghalensis*) leaves were shade-dried and cut into 1.5 cm discs. They were autoclaved, separately loaded into fine mesh bags (mesh size, 1 mm) and introduced into the cave stream in three locations to be sampled during 1-, 2-, 4-, 6- and 8-week intervals.

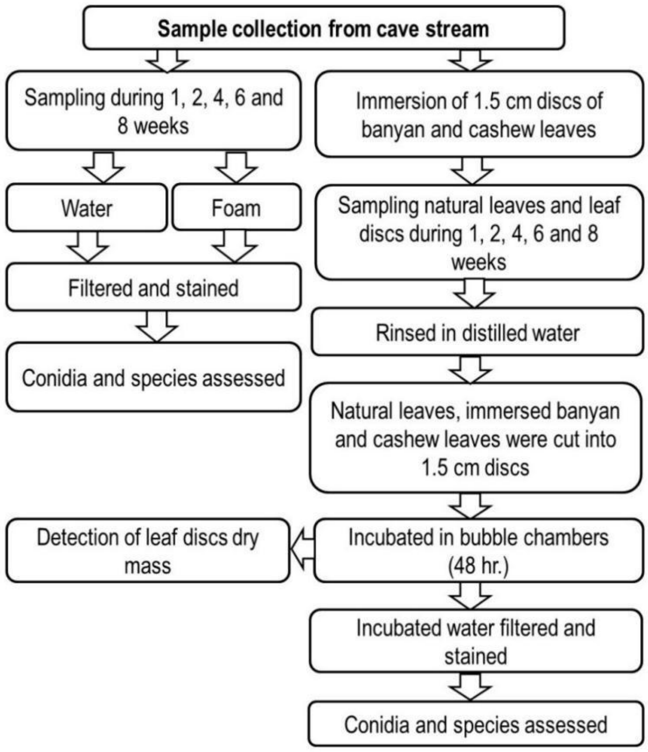

Fig. 1. Schematic presentation of the sampling procedure and assessment of aquatic hyphomycetes in cave stream samples.

Water analysis: The temperature of cave stream water was monitored by a thermometer (Model # 17873, N.S. Dimple Thermometer, New Delhi, India). The pH of water, conductivity, and total dissolved solids (TDS) were assessed by a water analysis kit (Water Analyzer 371, Systronics India Ltd., Ahmedabad, Gujarat, India) and the rest using a nanophotometer (18V DC, 50VA) (Serial # 1769, IMPLEN GmbH, Munich, Germany). The following analysis was according to APHA (2017). Dissolved oxygen in samples was assessed by Winkler's method, total hardness was determined by ethylene diamine tetraacetic acid (EDTA) titration using eriochrome black-T and murexide indicators and the total alkalinity was determined by titration using methyl orange and phenolphthalein indicators. Phosphate was assessed by the stannous chloride method, while sulphate by turbidometric, nitrate by brucine-sulfanilic acid, silicate by molybdosilicate and chloride by argentometric methods. Magnesium was determined by the difference between hardness and calcium as $CaCO_3$.

Water filtration: Four water samples, each of 25 ml, collected from the cave stream, were filtered (MF-Millipore membrane filter #SMWP02500) (mixed cellulose esters; diam., 25 mm; porosity, 5 µm). The filters were immediately stained with a few drops of 1% lactophenol aniline blue and preserved in the dark for a few days to screen by a microscope (Nikon, Model: ECLIPSE Ni-U 941966, Nikon Corporation, Tokyo,

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Japan) for assessment of aquatic hyphomycete conidia by mounting filters with a few drops of lactic acid.

Foam filtration: Freshly accumulated foam samples were collected from three locations of the cave stream in a wide-mouthed container using a spoon, brought to the laboratory, and processed within 30 min. Foam samples were diluted with distilled water and aliquots of diluted foam samples were filtered by Millipore filters, followed by staining with lactophenol aniline blue (Bärlocher 2020). The filters were screened as detailed in water samples and 300 conidia per sample were randomly scored for the quantitative and qualitative estimation of conidia lodged on the filters.

Leaf disc immersion: The cave stream and immersion of leaf discs into the cave stream are given in Fig. 2. Leaf discs of cashew and banyan packed in mesh bags (mesh size, 1 mm) were immersed in to the cave stream. They were retrieved in different time intervals (1-, 2-, 4, 6-, and 8-weeks) to assess colonization of aquatic hyphomycetes in bubble chambers (Bärlocher 2020).

Fig. 2. a, Empty finely meshed litter bags (mesh size, 1 mm); b, litter bags loaded with leaf disks; c, surroundings of the entry point of the cave stream; d and e, submersion of litter bags in the cave stream.

Bubble chamber incubation: Naturally submerged leaf litter was collected from three locations of the cave stream (1-, 2-, 4-, 6- and 8-weeks) and brought to the laboratory. Four to five different leaves were rinsed in water, piled, and cut into 1.5 cm disks. Five to six leaf discs were transferred to Erlenmeyer flasks (250 ml) containing sterile distilled water (150 ml) (Bärlocher 2020). They were aerated with a jet of bubbles by an aquarium aerator using Pasteur pipettes for up to 48 hr. (the Pasteur pipettes heads were plugged with cotton to avoid contamination from air). Incubated water was filtered and stained, as detailed above, to assess conidia. The dry weight of leaf discs in each flask was evaluated gravimetrically (drying at 80 °C for 24 hr. in a hot-air oven). Average conidia in three replicate leaf samples collected during 1-, 2-, 4-, 6- and 8-weeks were assessed on a dry mass basis. Similar to naturally accumulated leaf litter, submerged leaf litter discs (banyan and cashew) were collected during 1-, 2-, 4-, 6- and 8-weeks and processed to ascertain the release of conidia on bubble chamber incubation to compute on a dry leaf mass basis.

Identification: Aquatic hyphomycetes conidia found in water, foam, natural leaf litter and submerged leaf discs (banyan and cashew) were identified based on morphology and measurements using a high-power microscope (Nikon, Model: ECLIPSE Ni-U 941966, Nikon Corporation, Tokyo, Japan) and literature (Ingold 1975, Subramanian and Bhat 1981, Nawawi 1985, Marvanová 1997, Santos-Flores and Betancourt-Lopez 1997, Zhao et al. 2007, Bärlocher and Marvanová 2010, Gulis et al. 2020).

Data analysis: The relative abundance (RA) of aquatic hyphomycetes in water, foam, natural leaf litter and submerged leaf discs (banyan and cashew) was calculated as follows:

$$RA\ (\%) = \left(\frac{Fs}{Fa}\right) \times 100$$

Where Fs is the frequency of occurrence of each species and Fa is the sum of the frequencies of occurrence of all species. The percent relative abundance (RA) was calculated from the mean conidia of each species.

The diversity [Simpson's diversity (D') and Shannon's diversity (H')] and Pielou's equitability (J') for aquatic hyphomycetes in water, foam, natural leaf litter and submerged leaf discs (banyan and cashew) were calculated (Pielou 1975, Magurran 1988).

$$D' = \left(\frac{1}{\sum(pi)2}\right) \times 100$$

$$H' = -\sum\ (pi \ln pi)$$

Where pi is the proportion of individuals that species i contributes to the total.

$$J' = \left(\frac{H'}{H'max}\right)$$

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Where *H'max* is the maximum value of diversity for the number of species present.

Results and Discussion

Water quality: Atmospheric humidity and temperature at the sampling sites of the cave ranged from 81.3 to 94 and 24.3 to 28.3 °C, respectively (Table 1). The cave stream water temperature was in the mesophilic range (22.4–24.9 °C). The pH of the water ranged from 7.1–8.5 and became alkaline during the eighth week (8.5). Conductivity was lowest during the second week (58.3 µS/cm), while it was highest during the sixth week (122.5 µS/cm). The TDS ranged between 7 and 9.2 m g/l, with the highest during the second week. The dissolved oxygen ranged between 7.9 and 8.1 mg/l. The total hardness ranged between 99.6 and 109.3 mg/l. Total alkalinity ranged from 87.7–122.6 mg/l. Phosphate, sulphate, nitrate, and magnesium ranged from 0.5 to 4.4 mg/l. Silicate content ranged from 22.5–44.2 mg/l, while chloride content ranged from 39.8 to 70.4 mg/l.

Conidia in water: Water filtration on five occasions resulted in the recording of conidia of 12 species of aquatic hyphomycetes (range, 3–6 spp.; mean, 4.6 spp.) (Fig. 3). The conidia in water were highest in the first week with a steady increase and reached 267 cumulative conidia in the eighth week with an average conidial score of 53.4/g. *Anguillospora longissima*, *Flagellospora curvula*, *F. penicillioides*, *Lunulospora curvula* and *Tricladium* sp. were the top five species (Table 2). Interestingly, these fungi were also among the top five species of naturally submerged leaves as well as immersed leaf discs in this study. In an earlier study in four cave streams, water filtration yielded 14 species and the top three species were similar to this study (Sharathchandra and Sridhar 2021). Usually, water filtration results in a smaller number of species as well as conidia, depending on the availability of substrates (leaf and woody litter) (Sridhar and Kaveriappa 1984).

Conidia in foam: Foam filtration and scoring 300 conidia in each sampling yielded 10 species (range, 7–9 spp.; mean, 8 spp.) (Fig. 3). Cumulative species in foam samples were constant after the second week (10 spp.). The number of species in foam samples was lowest compared to water, natural, banyan and cashew leaves (10 vs. 11–19 spp.). *Anguillospora crassa*, *A. longissima*, *Flagellospora curvula*, *Helicomyces colligatus* and *Lunulospora curvula* were the top five species (Table 3). Similar to our study, except for *H. colligatus*, the remaining four species were the top five species (Sharathchandra and Sridhar 2021). As seen in our study, in cave streams, the foam samples represented the least number of species (7 spp.) compared to water, leaf litter and woody litter (7 vs. 9–15 spp.) (Sharathchandra and Sridhar 2021). Earlier studies in the coastal and Western Ghat streams represented the high species richness in foam samples (Sridhar et al. 1992). However, the foam from the cave stream in our study represented the least number of species compared to water and leaf litter, possibly due to the low flow regime.

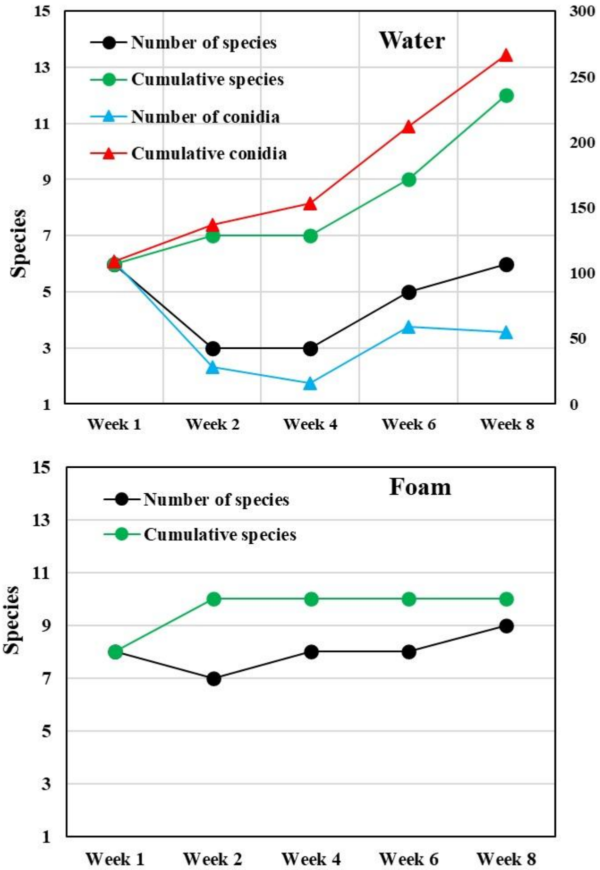

Fig. 3. Species and conidial richness of aquatic hyphomycetes in water and foam samples of cave stream. The number of species and number of conidia followed a similar pattern, as did the cumulative species and cumulative conidia.

Fungi in natural leaf litter

Naturally submerged leaf litter on bubble chamber incubation showed colonization of the highest of 19 species (range 4–11 spp.; mean, 6.8 spp.) (Fig. 4). Species richness was the highest in the fourth week (11 spp.) and total species was higher than cashew and banyan leaves (19 vs. 11–15 spp.). Conidial richness was the highest at the second week (300/g); cumulative conidia reached 783.1 on the 8th week with an average score of 156.6/g, which is higher than cashew leaves (152.6/g) and lower than banyan (199.8/g) leaves. *A. crassa*, *A. longissima*, *Cylindrocarpon* sp., *F. curvula* and *L. curvula* were the top five species (Table 4). Similar to the current study, except for *Cylindrocarpon* sp., the above four species were the top five species in natural leaf litter in cave streams (Sharathchandra and Sridhar 2021). The species richness found in leaf litter

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in cave streams is comparable to that in a nearby coastal Konaje stream (Sridhar et al. 1992, 2013).

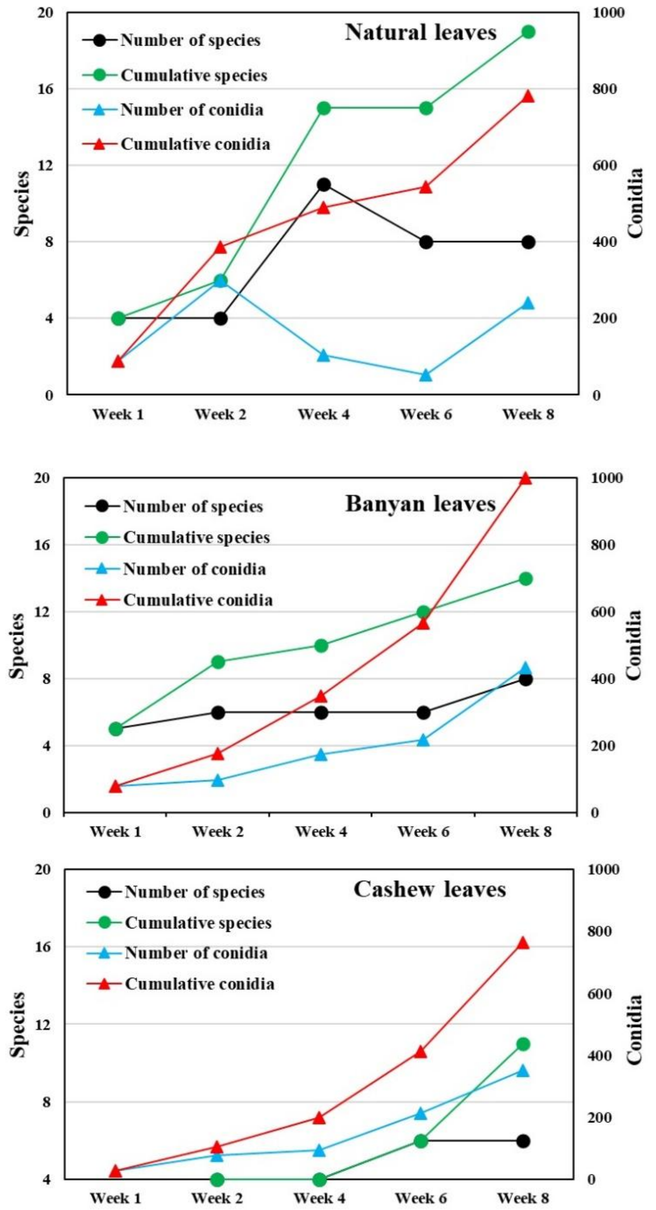

Fig. 4. Species and conidial richness of aquatic hyphomycetes in natural leaf litter and immersed leaf litter (cashew and banyan) in cave stream. The number of species in natural leaves was higher than that in immersed cashew and banyan leaf discs, as did the number of conidia.

Fungi in cashew leaf discs: Submerged cashew leaves supported a total of 11 species (range, 3–6 spp.; mean, 4.6 spp.) (Fig. 4). The species richness was lower than that of natural and banyan leaves (11 vs. 15–19 spp.). Conidial richness was highest on the eighth week (350.3/g); cumulative conidia reached 763.1 on the eighth week with an average score of 152.6/g, which is similar to naturally submerged leaves (156.6/g) but lower than banyan leaves (199.8/g). Compared to natural leaves and banyan leaves, cashew leaves possess low species richness and low conidial output. Such low species richness as well as conidial output may be due to the presence of more phenolics in cashew than banyan leaves. However, as and when time lapsed (1–8 weeks), the species and conidial richness gradually increased, possibly due to a decrease in phenolic content (Sridhar and Kaveriappa 1989). *A. longissima*, *F. curvula*, *Ingoldiella hamata*, *L. curvula* and *Triscelophorus acuminatus* were the top five species on cashew leaves (Table 5). *A. longissima*, *F. curvula* and *L. curvula* were also among the top five species in natural as well as banyan leaves.

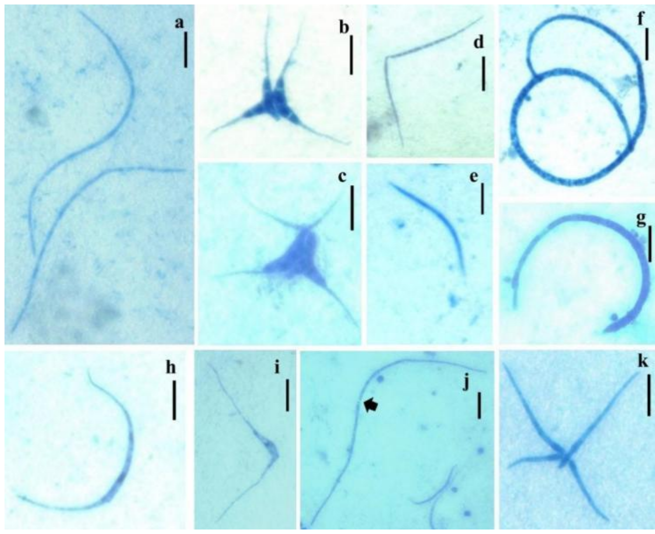

Fig. 5. Conidia of: a, *Anguillospora longissima*; b, *Campylospora chaetocladia*; c, *Campylospora filicladia*; d, *Condylospora spumigena*; e, *Flagellospora curvula*; f, *Helicomyces colligatus*; g, *Helicosporium* sp.; h, *Lunulospora curvula*; i, *Lunulospora cymbiformis*; j, *Synnematophora constricta* (arrow, deep constriction); k, *Triscelophorus acuminatus* (scale bar: 20 µm).

Fungi in banyan leaf discs: Submerged banyan leaves showed colonization of 14 species (range, 5–8 spp.; mean, 6.2 spp.), with the highest of eight species at week eight (Fig. 4), which is lower than natural leaves (19 spp.) and higher than cashew leaves (11 spp.). Similar to species richness, the conidial richness also reached a peak at the eighth week (432.5/g); cumulative conidia reached 999.2, which is higher than natural (783.1) as well as cashew (763.1) leaves. The average conidia in banyan leaves (199.8/g) are higher than in natural and cashew leaves (152.6–156.6/g). *A. longissima*, *F. curvula*, *L. curvula*, *T. acuminatus* and *Triscelophorus konajensis* were the top five species (Table 6). *A. longissima*, *F. curvula* and *L. curvula* were also among the top five species in natural as well as cashew leaves. Immersion of banyan leaves in the Konaje stream yielded 16–17 species of aquatic hyphomycetes in 8 weeks, with 2442 conidia per gram of dry mass (Sridhar and Kaveriappa 1989, Sridhar et al. 2013).

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Table 1. Physicochemical parameters of water samples from the cave stream (n=3, mean).

	Week 1	Week 2	Week 4	Week 6	Week 8	Range
Air temperature (°C)	28.3±0.58	24.3±0.58	25.7±0.64	26.4±0.53	26.0±0.20	24.3–28.3
Humidity (%)	87.33±0.58	94.0±0	92.7±1.12	81.3±1.16	90.8±1.10	81.3–94.0
Water temperature (°C)	22.5±0.50	23.0±0.20	24.0±0.06	24.9±0.12	22.4±0.20	22.4–24.9
pH	7.6±0.16	7.1±0.12	7.6±0.15	7.6±0.15	8.5±0.24	7.1–8.5
Conductivity (μS/cm)	72.3±2.5	58.3±3.51	90.5±2.3	122.5±2.5	112.1±3.3	58.3–122.5
Total dissolved solids (mg/l)	8.6±0.2	9.2±0.1	7.1±0.2	7.0±0.2	7.8±0.1	7.0–9.2
Dissolved oxygen (mg/l)	8.1±0.24	7.9±0.39	8.1±0.24	8.1±0.24	8.1±0.24	7.9–8.1
Total hardness (mg/l)	108.7±4.2	109.3±3.1	99.6±4.9	118.7±4.2	107.8±2.3	99.6–109.3
Total alkalinity (mg/l)	87.7±7.5	103.5±7.7	88.3±3.5	106.0±3.6	122.6±2.5	87.7–122.6
Phosphate (mg/l)	1.0±0.2	1.3±0.2	2.8±0.2	3.0±0.2	3.3±0.2	1.0–3.3
Sulfate (mg/l)	1.7±0.3	0.7±0.1	2.1±0.1	4.1±0.2	4.4±0.3	0.7–4.4
Nitrate (mg/l)	0.5±0.2	1.1±0.1	2.1±0.1	2.6±0.2	2.7±0.1	0.5–2.7
Silicate (mg/l)	22.5±2.1	27.6±1.5	40.4±2.1	44.2±2.0	36.7±1.2	22.5–44.2
Chloride (mg/l)	43.2±1.6	39.8±1.1	48.9±1.4	70.4±2.5	62.7±2.3	39.8–70.4
Magnesium (mg/l)	1.7±0.2	1.3±0.2	2.1±0.2	2.4±0.2	2.4±0.2	1.3–2.4

Table 2. Occurrence of conidia of aquatic hyphomycetes in water samples (*, n=3, mean) and their relative abundance (RA%) in the cave stream.

	Conidia/100 ml*					**Mean (n=15)**	**RA%**
	Week 1	**Week 2**	**Week 4**	**Week 6**	**Week 8**		
Anguillospora longissima	8	5	4	21	29	13.4	24.7
Flagellospora curvula	25	19	-	-	-	8.8	16.2
Lunulospora curvula	25	-	7	8	4	8.8	16.2
Tricladium sp.	38	-	-	-	-	7.6	14.0
Flagellospora penicillioides	5	-	5	8	5	4.6	8.5
Lunulospora cymbiformis	-	-	-	13	-	2.6	4.8
Cylindrocarpon sp.	-	-	-	9	-	1.8	3.3
Flagellospora penicillioides	-	-	-	-	9	1.8	3.3
Condylospora spumigena	-	-	-	-	4	1.6	3.0
Triscelophorus acuminatus	8	-	-	-	-	1.6	3.0
Tetracladiium marchalianum	-	4	-	-	-	0.8	1.5
Tricladium sp.	-	-	-	-	4	0.8	1.5

Table 3. Occurrence of conidia of aquatic hyphomycetes in foam samples (*, n=3, mean) and their relative abundance (RA%) in the cave stream.

	Conidia of species/300 conidia*					**Mean (n=15)**	**RA%**
	Week 1	**Week 2**	**Week 4**	**Week 6**	**Week 8**		
Lunulospora curvula	57	96	132	33	12	66.0	22.0
Anguillospora crassa	39	33	69	96	63	60.0	20.0
Anguillospora longissima	75	18	21	66	93	54.6	18.2
Flagellospora curvula	21	63	33	30	15	32.4	10.8
Helicomyces colligatus	42	-	15	15	69	28.2	9.4
Lunulospora cymbiformis	-	69	-	18	6	18.6	6.2
Triscelophorus konajensis	39	-	9	30	15	18.6	6.2
Cylindrocarpon sp.	-	6	-	12	24	8.4	2.8
Triscelophorus acuminatus	21	-	15	-	-	7.2	2.4
Tricladium sp.	6	15	6	-	3	6.0	2.0

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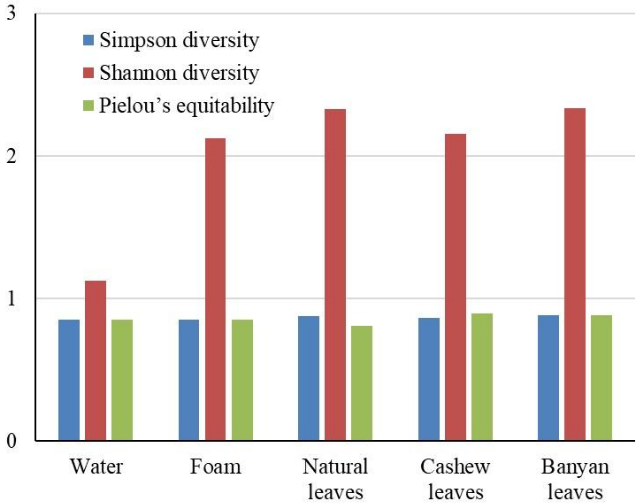

Fig. 6. Diversity (Simpson and Shannon) and Pielou's equitability of aquatic hyphomycetes occurring in water, foam, natural leaf litter and immersed leaf litters (cashew and banyan).

Species richness and diversity: The richness of species was highest in natural leaves, followed by banyan leaves, water samples, cashew leaves and foam samples (Fig. 3 and Fig. 4). In water, foam, natural leaves and submerged leaves (cashew and banyan), three aquatic hyphomycetes were common in the top five species (*A. longissima*, *F. curvula* and *L. curvula*). Among these species, *H. collegatus*, *Lunulospora cymbiformis* and *Synnematophora constricta* are rare and not reported in earlier investigations (Sridhar et al. 1992, 2013). Representative conidia of aquatic hyphomycetes found in the cave stream have been presented (Fig. 5). Shannon diversity was the highest in natural leaves, followed by banyan leaves, cashew leaves and foam samples. There was no drastic difference in Simpson diversity as well as Pielou's equitability among the five samples studied (Fig. 6).

Conclusions

Aquatic hyphomycetes asexually reproduce in lotic habitats by growing mainly on the submerged leaf litter. They release sigmoid, multiradiate and helicoid conidia from leaf litter. Unlike the seasonal streams, the cave streams consist of flowing water throughout the year in southwest India. The current study demonstrated that cave streams are also the ideal ecological niches for aquatic hyphomycetes. *Anguillospora longissima*, *Flagellospora curvula* and *Lunulospora curvula* were common among the top five species in water, foam, and leaf litter (natural, cashew and banyan). Among the aquatic hyphomycetes reported in the lateritic cave stream, six species are new records to southwest India (*Helicomyces collegatus*, *Lunulospora cymbiformis*, *Phalangispora bharathensis*, *Synnematophora constricta*, *Tetracladium marchalianum* and *Trisulcosporium acerinum*). Usually, *Lunulospora cymbiformis* and *Synnematophora constricta* occur in the cold climate conditions of the Western Ghats; however, these species were represented in the cave stream in the present study, possibly due to the relatively low water temperature compared to open streams. The occurrence and colonization of leaf litter in lateritic cave streams indicates the capability of aquatic hyphomycetes to colonize and adapt to new ecological niches. Further studies on cave stream dwelling aquatic hyphomycetes, adaptability and ability to degrade organic matter will enable us to understand their population ecology.

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Table 4. Occurrence of aquatic hyphomycetes in leaf discs of naturally submerged leaf litter (*, n=3, mean conidia/g dry mass) and their relative abundance (RA%) in the cave stream.

	Conidia/g dry mass*					**Mean (n=15)**	**RA%**
	Week 1	**Week 2**	**Week 4**	**Week 6**	**Week 8**		
Anguillospora crassa	-	155.6	-	3.3	-	31.8	20.1
Flagellospora curvula	25.0	111.1	-	6.7	10.0	30.6	19.3
Cylindrocarpon sp.	-	-	53.1	16.2	30.0	19.9	12.6
Anguillospora longissima	37.5	11.1	6.3	1.1	40.0	19.2	12.1
Lunulospora curvula	-	-	-	-	60.0	12.0	7.6
Flagellospora penicillioides	-	-	-	-	50.0	10.0	6.3
Triscelophorus acuminatus	12.5	-	-	-	20.0	6.4	4.0
Triscelophorus monosporus	-	-	3.1	6.3	20.0	5.9	3.7
Campylospora chaetocladia	-	-	9.4	6.3	-	3.1	2.0
Phalangispora bharathensis	-	-	6.3	9.4	-	3.1	2.0
Phalangispora constricta	-	11.1	3.1		-	2.8	1.8
Helicosporium sp.	12.5	-	-	-	-	2.5	1.6
Triscelophorus konajensis	-	11.1	-	-	-	2.2	1.4
Condylospora spumigena	-	-	-	-	10.0	2.0	1.3
Trisulcosporium acerinium	-	-	3.1	-	-	1.6	1.0
Trisulcosporium sp.	-	-	3.1	-	-	1.6	1.0
Alatospora acuminata	-	-	6.3	-	-	1.3	0.8
Wiesenriomyces laurinus	-	-	6.3	-	-	1.3	0.8
Flabellospora crassa	-	-	3.1	3.1	-	1.2	0.8

Table 5. Occurrence of aquatic hyphomycetes in submerged cashew leaf discs (*, n=3; mean conidia/g dry mass) and their relative abundance (RA%) in the cave stream.

	Conidia/g dry mass*					**Mean (n=15)**	**RA%**
	Week 1	**Week 2**	**Week 4**	**Week 6**	**Week 8**		
Anguillospora longissima	-	33.3	25.0	66.7	67.5	38.5	25.2
Lunulospora curvula	9.1	13.3	12.5	66.7	-	20.3	13.3
Triscelophorus acuminatus					80.0	16.0	10.5
Flagellospora curvula	8.7	13.3	50.0	6.7	-	15.7	10.3
Ingoldiella hamata	-	-	-	-	67.5	13.5	8.9
Helicomyces colligatus	-	-	-	-	67.3	13.5	8.9
Cylindrocarpon sp.	-	-	-	66.7	-	13.3	8.7
Triscelophorus monosprous	-	-	-	-	57.5	11.5	7.5
Anguillospora crassa	9.1	18.8	6.3	3.3	-	7.5	4.9
Tricladium sp.	-	-	-	-	10.5	2.1	1.4
Lunulospora cymbiformis				3.3	-	0.7	0.5

Table 6. Occurrence of aquatic hyphomycetes in submerged banyan leaf discs (*n=3, mean conidia/g dry mass) and their relative abundance (RA%) in the cave stream.

	Conidia/g dry mass*					**Mean (n=15)**	**RA%**
	Week 1	**Week 2**	**Week 4**	**Week 6**	**Week 8**		
Flagellospora curvula	8.7	31.3	41.1	38.3	75.0	38.9	19.5
Triscelophorus acuminatus	-	31.3	-	66.7	72.5	34.1	17.1
Anguillospora longissima	13.0	6.3	-	41.2	50.4	22.2	11.1
Triscelophorus konajensis	-	-	-	18.4	85.0	20.7	10.4
Lunulospora curvula	13.0	-	44.4	36.7	-	18.8	9.4
Condylospora spumigena	-	18.8	21.1	-	50.0	18.0	9.0
Campylospora chaetocladia	-	-	-	-	51.5	10.3	5.2
Anguillospora crassa	17.4	-	33.3	-	-	10.1	5.1

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Campylospora filicladia	-	-	-	-	40.6	8.1	4.1
Lunulospora cymbiformis	-	-	22.2	-	7.5	5.9	3.0
Cylindrocarpon sp.	26.1	-	-	-	-	5.2	2.6
Flagellospora penicillioides	-	-	-	16.7	-	3.3	1.7
Synnematophora contricta	-	3.3	11.1	-	-	2.9	1.5
Triscelophorus monosprous	-	6.3	-	-	-	1.3	0.7

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