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Colonization & Decomposition Pattern of Water Borne Conidial Fungi in Freshwater Stream of Central Himalaya

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ABSTRACT

In the freshwater streams the leaf litter substrate is colonized by early fungal colonizer and helps in decomposition of leaf litter and makes the substrate more suitable for the recruitment of late successional species. The study was carried out at Central Himalayan stream (Vinayak) to examine the colonization and decomposition pattern of Water Borne Conidial Fungi as all the streams are naturally subjected to great spatial and temporal variability, which is likely to affect the distribution and activity of organism in aquatic ecosystem. In this study nylon-mesh bags technique was used for the period of twelve months, using Angiospermic and Gymnospermic leaves as leaf litter substrate. Decomposition (weight loss) of different substrates in different months of submergence was analyzed statistically and was found that species number significantly affect the weight loss of tested leaf litter.

KEY WORDS: Water Borne Conidial Fungi, Fresh Water Streams, Colonization, Decomposition.

INTRODUCTION

Mycoflora of freshwater bodies show a great diversity of Water Borne Conidial Fungi which are characterized by magnificent spore types and are anamorphs of Ascomycota and Basidiomycota occurring mainly in lotic water (Pascoal et al. 2005). They are the principal fungal colonizer of plant detritus in streams, rivers and form an important trophic link between decaying leaves and stream invertebrates (Barlocher 1992; Abdel-Raheem 1997; Garnett et al. 2000; Mobeen Arshad et al. 2007). Among all the fungi which colonize the submerged leaves, Water Borne Conidial Fungi are known to be the most active group. Fungal colonization of Water Borne Conidial Fungi increases the nutritive value of leaves and detritivores prefer such colonized leaves (Graca et al. 1993; Gessner and Chauvet 1994; Gessner et al. 1997; Graca 2001; Graca et al. 2016). They considerably help in the energy flow of streams (Baldy et al. 1995; Gulis and Suberkropp 2003; Methvin and Suberkropp 2003).

The pattern of colonization by Water Borne Conidial Fungi on leaf litter has been studied by various workers (Sridhar and Kaveriappa 1989; Chandrashekar et al. 1989; Sati and Pant 2006). Newton (1971) observed that freshly fallen leaf material into the river quickly attracts a number of fungal colonists. Fisher et al. (1977) found that these fungi are very efficient decomposers of lignin and cellulose in addition to conversion of free nitrogen into proteins.

In view of all the importance of Water Borne Conidial Fungi as colonizer of leaf litter and releasing of nutrients for the uptake of aquatic detritus this study was carried out to check the colonization and decomposition pattern of these fungi in two different leaf litter. The study was carried out at Central Himalayan stream (Vinayak) situated at (1500 m asl) of Nainital, to examine colonization and decomposition pattern of Water Borne Conidial Fungi by using the nylon-mesh bag technique.

MATERIALS AND METHODS

Old leaves of Angiospermic and Gymnospermic plants viz., oak (*Quercus floribunda* Lindl.) and pine (*Pinus roxburghii* Sarg.) were used for this study. These were collected from appropriate trees before the leaf fall and were oven dried at 50 °C for 3 days. 5g oven dried leaves of each tree species oak, pine and mixture of these (oak + pine) were placed separately inside the 1 mm^2 pore size nylon-mesh bags (15 × 15 cm in size) (**Plate 1**). Three sets consisting each of 36 bags (12 bags each of oak, pine and mixed litter) were kept in iron net boxes in 3 sets (**Plate 2**). One each set of these iron net boxes was submerged into running freshwater stream at Vinayak in different 3 sites of nearly 100 m. distance (**Plate 3**).

A total 9 bags, 3 each of oak, pine and mixed litter from 3 different sites of stream were recollected periodically at monthly intervals. Collected litter bags were kept in the sterile polythene bags. On return to laboratory samples of each bags were washed individually with running tap water for at least 2 hrs and then rinse with sterile distil water. These samples were kept for incubation in sterilized water for 2-3 days for developmental stages, spore morphology and spore release. The conidia were identified and recorded for each type of leaf samples at different stages of submergence. After observing them in microscope the samples were then kept for oven drying at 80 °C for 3 days, to determine the weight loss in bags. Oven dried samples were then allowed to cool down at room temperature and weighed.

RESULTS

The results of oak, pine and mixed leaf litter colonization are summarized in **table 1, 2, 3** respectively. In this investigation altogether 26 species of Water Borne Conidial Fungi belonging to 18 genera were recorded as the colonizers of oak, pine and mixed litter (**Table 4**).

Colonization of Oak litter (*Quercus floribunda* Lindl.):

24 species of Water Borne Conidial Fungi were recovered from the oak leaf litter during study (**Table 1**). Thirteen species were found to colonize the oak leaves within one month of submergence and may be designated as early colonizers. Gradual decline in species number was observed in following months (**Fig 1**).

Lunulospora curvula and *L. cymbiformis* once established in I^{st} month were able to maintain their position till 10 months of submergence. *Heliscella stellatacula* colonized oak litter from 1^{st} month to 4^{th} month of submergence only. *Camposporium pellucidum* and *Campylospora chaetocladia* occurred on 2^{nd} to 8^{th} month. However, *Cylindrocarpon aquaticum* was found to colonize only on 3^{rd} month of submergence.

The maximum numbers of conidia were observed on 2^{nd} month (19 species) and minimum number of conidia on 9^{th} month (6 species). In the 11^{th} and 12^{th} month a little mass of substrate remained and no Water Borne Conidial Fungi were observed.

In first 3 months Water Borne Conidial Fungi colonizing oak leaf litter produced abundant conidia. However, there was a decline in conidial production in the decomposed substrate during later months.

The succession pattern of Water Borne Conidial Fungi on oak leaf litter showed that *Alatospora pulchella*, *Camposporium pellucidum*, *Campylospora chaetocladia*, *Setosynnema isthmosporum*, *Speiropsis scopiformis*, *Tetracladium marchalianum*, *Triscelophorus acuminatus* and *T. monosporus* colonized substrate only after one month of submergence, and may be called as secondary colonizers. *Cylindrocarpon aquaticum* and *Tetracladium setigerum* after 2 months of submergence and *Pestalotiopsis submersus* was recovered from 3^{rd} month onwards of submergence along with the primary and secondary colonizers (**Table 1**).

Colonization of Pine litter (*Pinus roxburghii* Sarg.):

A total of 17 species of Water Borne Conidial Fungi were recorded to colonize pine litter at different stages of submergence (**Table 2**). Of these 11 species were observed after 30 days of submergence and could be regarded as early colonizers. The species composition had variation in following months. Whereas, species number remained low in 7th month but inclined in 8th and 9th month. There were abundant conidia in the initial months of collection but it gradually declined in later months with progressive decomposition of substrate (**Fig. 1**).

Alatospora acuminata and *Clavariopsis aquatica* colonized from first month of submergence till the end of 12 months decomposition except once in 6th and 8th month respectively. *Flagellospora penicillioides* was found as new addition to colonize pine needle as it was absent in the oak litter. *Heliscella stellatacula* was observed colonizing pine needle only on 1st to 3rd month and never grew in the following months. *Lemonniera cornuta* appeared in first 2 months and disappeared from 3-7 months of collections. *Campylospora chaetocladia* colonized pine needle substrate from 4th to 7th months.

The maximum numbers of species were observed in 2nd month of submergence (15 species) and minimum numbers of conidia were observed in 11th and 12th months (6 species each) of collection when a small quantity of litter remained in the litter bags.

The colonization and successional pattern of Water Borne Conidial Fungi showed that *Flagellospora penicillioides*, *Setosynnema isthmosporum*, *Triscelophorus acuminatus* and *T. monosporus* were found as secondary colonizers appeared after 30 days of submergence. *Speiropsis scopiformis* appeared after 2nd month and *Campylospora chaetocladia* after 3rd month of submergence.

Colonization of Mixed litter (Oak + Pine):

To study the combined effect of Water Borne Conidial Fungi on colonization and the successional pattern mixed leaf litter of oak and pine was used. In the mixed litter 25 species of Water Borne Conidial Fungi were found to colonize the substrate (**Table 3**). Maximum numbers of conidia were observed in 2nd-3rd months (17 species each) and minimum number in last three months of collection when a small quantity of litter left in collection bags (6 species each in 10-12 months).

In the initial months of collection there was increment in the species number as well as abundant conidia but the species composition altered in 6th month with a decline in the species number and conidial production. However, it was then again increased till 9th month with a gradual decline in subsequent months (**Fig 1**).

Alatospora acuminata, *Anguillospora longissima*, *Clavariopsis aquatica*, *Dimorphospora foliicola*, *Heliscella stellatacula*, *Heliscus lugdunensis*, *Lemonniera cornuta*, *Lunulospora curvula*, *L. cymbiformis*, *Tetrachaetum elegans* and *Tetracladium marchalianum* were found as early colonizers. *Alatospora pulchella*, *Camposporium pellucidum*, *Cylindrocarpon aquaticum*, *Speiropsis scopiformis*, *Triscelophorus acuminatus* and *T. monosporus* colonized the mixed litter with early colonizers after 1st month as secondary colonizers. *Campylospora parvula* and *Flagellospora penicillioides* colonized after 3rd month of submergence. *Lemonniera pseudofloscula* and *L. terrestris* were found as late colonizers, not being present before 7th months of submergence.

Alatospora acuminata, *Clavariopsis aquatica* and *Triscelophorus monosporus* colonized the substrate from starting month to last month of collection with little disruption in middle 1 or 2 months and can be called as regular species. *Alatospora pulchella* and *Camposporium pellucidum* occurred only in 2nd to 3rd month and 2nd to 4th month of collection respectively. *Lemonniera pseudofloscula* started colonization from 7th month to the last month of collection.

Microbial Decomposition and weight loss of different substrates:

The leaf litter weight loss in oak, pine and mixed litter at different stages of decomposition is presented in **table 5**. After 30 days of submergence weight loss was higher for all the substrate. The percent weight loss was 26.73%, 24.6% and 25.8% for oak, pine and mixed litter respectively (**Fig. 2-4**). In the following months the higher rate of weight loss was observed in oak litter and also it was found that decomposed oak litter was colonized by greater number of Water Borne Conidial Fungi as compared to pine and mixed litter (**Fig 1**). In later stages of decomposition, the number of colonized Water Borne Conidial Fungi decreases and it may be attribute to the availability of nutrients and leaf mass.

Colonization of Water Borne Conidial Fungi and weight loss of different substrates in different months of submergence was analyzed statistically and it was found that species number significantly affect the weight loss of litter. A negative correlation was found with weight loss of litter and species number of oak, pine and mixed litter ($r = -0.836$, $p<0.01$; $r = -0.637$, $p<0.05$ and $r = -0.786$, $p<0.01$ respectively).

DISCUSSION

The results obtained from the study revealed that the number of Water Borne Conidial Fungi colonizing different substrate varied considerably in the different months of submergence. As evident from **table 4** after one month of submergence oak litter was colonized with 13 species of Water Borne Conidial Fungi, while pine and mixed litter were colonized by 11 species each. In the following months oak was colonized with greater number of fungal species as compared to pine and mixed litter. Decomposition rate measured for all the tested leaf litter, oak litter showed greater weight loss than the mixed and pine. However, Suberkropp and Klug (1976) and Chamier and Dixon (1982) found that oak leaves typically support lower frequencies of Water Borne Conidial Fungi and are processed at slower rates than any other types of deciduous leaf litter in streams, certainly it would be due to different physico-chemical parameters of the stream (Sati & Arya 2009).

In the present study *Alatospora acuminata*, *Anguillospora crassa*, *A. longissima*, *Campylospora parvula*, *Clavariopsis aquatica*, *Dimorphospora foliicola*, *Heliscella stellatacula*, *Heliscus lugdunensis*, *Lemonniera cornuta*, *L. terrestris*, *Lunulospora curvula*, *L. cymbiformis*, *Tetrachaetum elegans* and *Tetracladium marchalianum* were found as primary colonizers of the oak, pine and mixed leaf litter. Sati and Pant (2006) have reported *Alatospora acuminata*, *Heliscus lugdunensis* and *Lunulospora curvula* reported as early colonizers in temperate streams. *Alatospora acuminata*, *Clavariopsis aquatica*, *Triscelophorus monosporus*, *Lunulospora curvula* and *L. cymbiformis* were recorded as regular species colonizing the tested leaf litters. Fungi with sigmoid conidia also dominated early succession in studies by Gessner and Chauvet (1993).

According to Barlocher and Oertli (1978) the presence of any inhibitors in substrate may influence the colonization of Water Borne Conidial Fungi and same substrate may be profusely colonized after submergence in the following water for certain duration, due to the removal of inhibitory compound by the running water. Less colonization of fungi may be due to unsuitability of the substrates. In the study different Water Borne Conidial Fungi were recorded at different intervals of submergence, suggesting possibility of the influence of nutritional changes and chemical changes including the removal of inhibitors by leaching.

Water Borne Conidial Fungi are well equipped with hydrolytic enzymes capable of degradation of all components of plant tissue (Shearer 1992). According to the study proposed by Baldy et al. (1995); Weyers and Suberkropp (1996) in stream ecology, aquatic fungi dominate the decomposition of leaf litter. Gulis and Suberkropp (2003) as well as Pascoal and Cassio (2004) suggested that contribution of bacteria for litter decomposition is often found to be minor. However, the only study (Bengtsson 1992) that has specifically addressed interactions between fungi and bacteria associated with submerged leaf litter in a laboratory microcosm suggested that fungal-bacterial interactions were synergistic.

CONCLUSION

This study demonstrates the colonization and decomposition pattern of different species of Water Borne Conidial Fungi in two known leaf litter species. The leaf litter was colonized by greater number of fungal species; however, fluctuation in the microbial colonization was different in different months of submergence (**Table 4-5**). Although water itself may be the sole background for the decomposition of leaf litter but the microbial colonization of Water Borne Conidial Fungi coupled with certain abiotic factors regulates the rate of decomposition.

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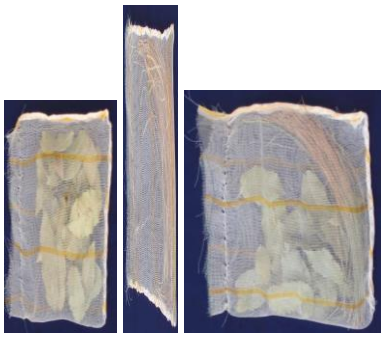


(i) (ii) (iii)

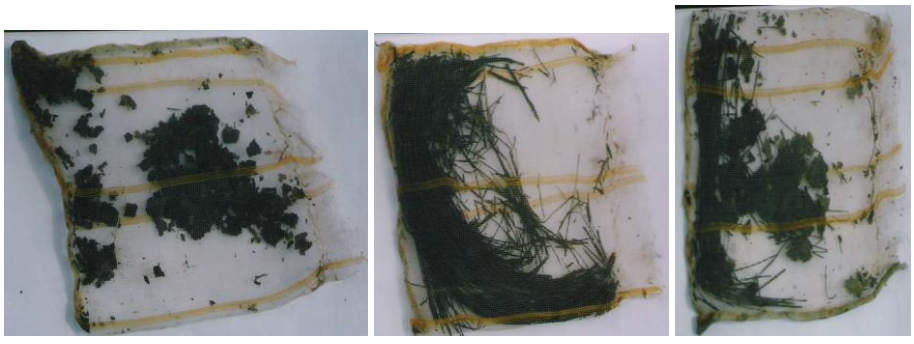
Plate 1: Nylon mesh litter bags with different substrate. (i)- Oak, (ii) - Pine and (iii) - Mixed (Oak + Pine)

(i) (ii)

Plate 2: (i) - 1 set of litter bags with different substrates, (ii) - 1 set of iron net box with litter bags

(i) (ii) (iii)

Plate 3: (i-iii): Placement of iron net boxes with set of litter bags into stream water



(i) (ii) (iii)

Plate 4: (i-iii): 8th month old nylon mesh bags with decomposed leaf litter (i)- Oak, (ii)- Pine and (iii)- Mixed (Oak + Pine)

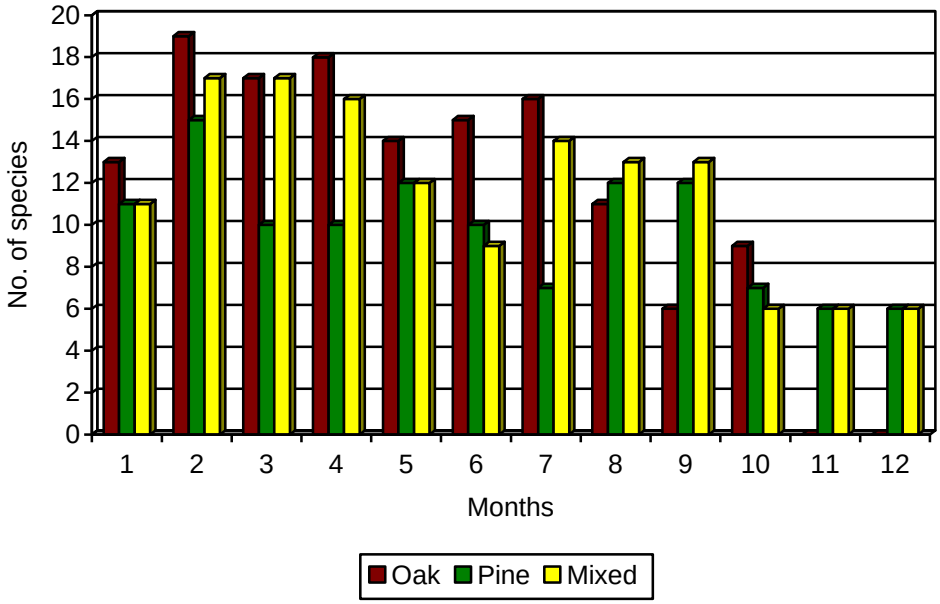


Fig. 1 Variation in colonization (species number) in Oak, Pine and Mixed litter at different stages of submergence

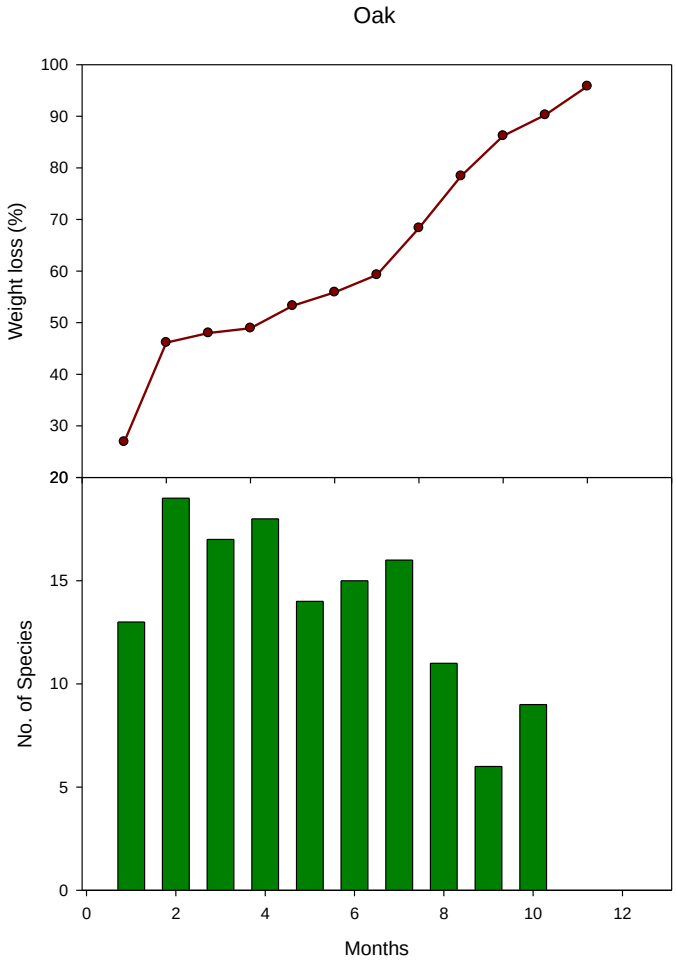


Fig. 2 Fungal colonization and weight loss in Oak litter at different stages of decomposition

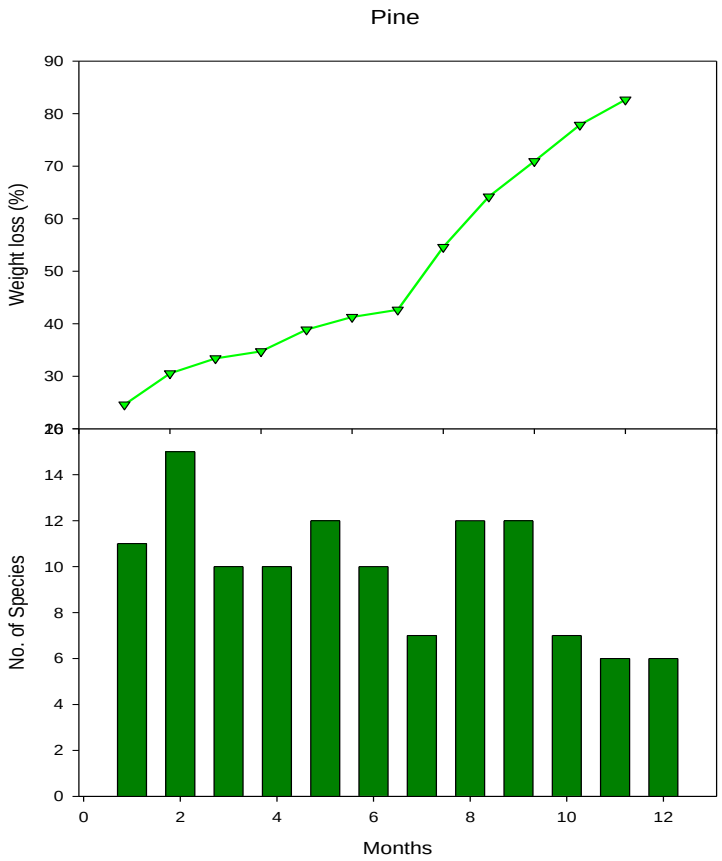


Fig. 3 Fungal colonization and weight loss in Pine litter at different stages of decomposition

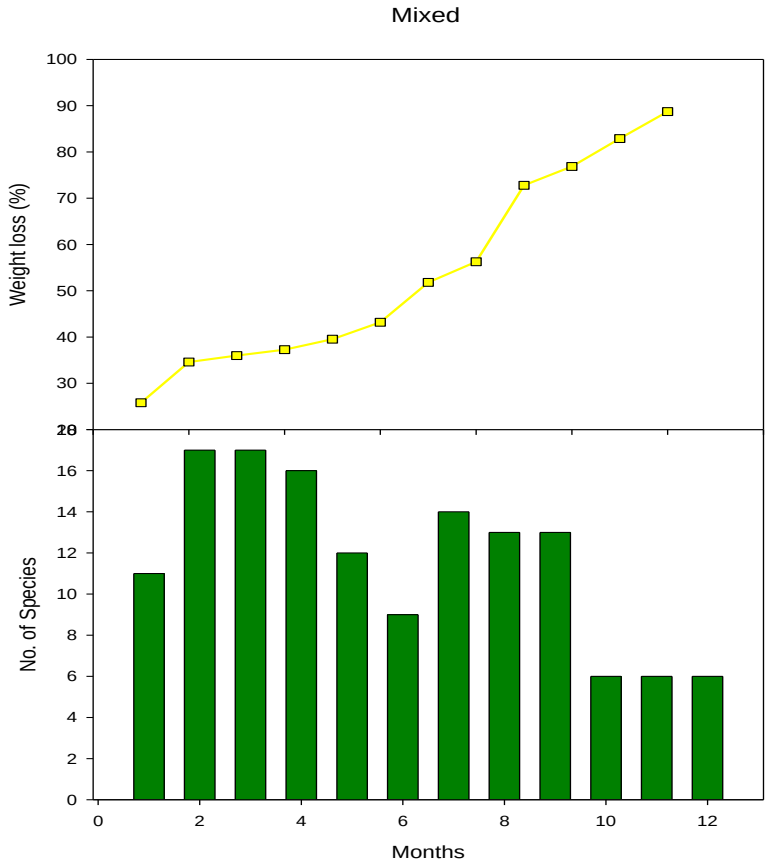


Fig. 4 Fungal colonization and weight loss in Mixed litter at different stages of decomposition

Table 1: Colonization of Water Borne Conidial Fungi on Oak leaf litter (*Quercus floribunda*) at different stages of submersion.

S. No.	Species	Collection months 1	2	3	4	5	6	7	8	9	10	11	12
1.	*Alatospora acuminata*	++	++	-	++	+	+	+	+	-	+	-	-
2.	*Anguillospora crassa*	++	++	++	+	-	+	+	-	-	-	-	-
3.	*A. longissima*	++	+++	-	++	-	+	+	+	+	-	-	-
4.	*Campylospora parvula*	+	-	+++	+	+	+	+	-	-	-	-	-
5.	*Clavariopsis aquatica*	+++	++	+++	-	++	++	+	+	+	+	-	-
6.	*Dimorphospora foliicola*	++	++	++	-	+	+	+	-	-	-	-	-
7.	*Heliscella stellatacula*	++	++	+	+	-	-	-	-	-	-	-	-
8.	*Heliscus lugdunensis*	+++	+++	++	+	++	-	+	-	-	-	-	-
9.	*Lemonniera cornuta*	++	+++	-	-	-	-	-	-	++	+	-	-
10.	*L. terrestris*	++	-	-	-	-	-	+	-	-	+	-	-
11.	*Lunulospora curvula*	+++	+++	+++	++	+	+	+	+	+	+	-	-
12.	*L. cymbiformis*	+++	+++	+++	++	++	+	+	+	+	+	-	-
13.	*Tetrachaetum elegans*	+++	+++	++	++	+	++	-	+	-	-	-	-
14.	*Alatospora pulchella*	-	+++	-	-	-	+	-	-	-	-	-	-
15.	*Camposporium pellucidum*	-	++	++	+++	+	++	+	+	-	-	-	-
16.	*Campylospora chaetocladia*	-	++	+++	+	++	+++	+	+	-	-	-	-
17.	*Setosynnema isthmosporum*	-	++	-	+++	++	+	+	-	-	-	-	-
18.	*Speiropsis scopiformis*	-	++	++	++	+	-	-	+	-	+	-	-
19.	*Tetracladium marchalianum*	-	+++	+++	++	++	-	+	+	-	+	-	-
20.	*Triscelophorus acuminatus*	-	+++	++	++	-	-	+	-	-	-	-	-

21.	*T. monosporus*	-	+++	+++	++	++	++	+	+	+	+	-	-
22.	*Cylindrocarpon aquaticum*	-	-	++	-	-	-	-	-	-	-	-	-
23.	*Tetracladium setigerum*	-	-	++	++	-	-	-	-	-	-	-	-
24.	*Pestalotiopsis submersus*	-	-	-	++	-	+	-	-	-	-	-	-
	Total	13	19	17	18	14	15	16	11	6	9		

+ = Less conidial production, ++ = Moderate conidial production, +++ = Abundant conidial production, - = Conidia absent

Table 2: Colonization of Water Borne Conidial Fungi on Pine needle (*Pinus roxburghii*) litter at different stages of submersion.

		Collection months											
S. No.	Species	1	2	3	4	5	6	7	8	9	10	11	12
1.	*Alatospora acuminata*	+++	+++	++	++	++	-	++	+	+	+	+	+
2.	*Anguillospora longissima*	+	+++	+	++	+	-	+	+	-	+	-	-
3.	*Campylospora parvula*	++	+	+	-	+	+	-	-	+	-	-	-
4.	*Clavariopsis aquatica*	+++	+++	++	+	++	++	+	-	+	+	+	+
5.	*Dimorphospora foliicola*	+++	++	-	-	-	-	-	+	-	-	+	-
6.	*Heliscella stellatacula*	++	++	+	-	-	-	-	-	-	-	-	-
7.	*Heliscus lugdunensis*	++	+	++	-	++	+	+	+	+	-	-	-
8.	*Lemonniera cornuta*	+++	++	-	-	-	-	-	+	++	+	+	+
9.	*Lunulospora cymbiformis*	+++	+++	-	+++	+++	++	-	+	+	+	-	+
10.	*Tetrachaetum elegans*	+++	+++	+++	+	+	-	-	+	+	-	-	-
11.	*Tetracladium marchalianum*	++	++	++	+	-	++	-	+	+	+	-	-
12.	*Flagellospora penicillioides*	-	+++	-	+++	++	++	++	+	+	-	+	+
13.	*Setosynnema isthmosporum*	-	++	-	-	++	++	-	-	-	-	-	-
14.	*Triscelophorus acuminatus*	-	+++	-	+++	++	-	-	+	+	-	-	-
15.	*T. monosporus*	-	+++	+++	-	+++	++	-	+	+	+	-	+
16.	*Speiropsis scopiformis*	-	-	++	+++	-	++	++	+	+	-	+	-
17.	*Campylospora chaetocladia*	-	-	-	+++	+++	+	+	-	-	-	-	-
	Total	11	15	10	10	12	10	7	12	12	7	6	6

+ = Less conidial production, ++ = Moderate conidial production, +++ = Abundant conidial production, - = Conidia absent

Table 3: Colonization of Water Borne Conidial Fungi on mixed leaf litter (oak+pine) at different stages of submersion.

		Collection months											
S. No.	Species	1	2	3	4	5	6	7	8	9	10	11	12
1.	*Alatospora acuminata*	++	+++	++	++	+	-	++	+	+	-	+	+
2.	*Anguillospora longissima*	+	+++	++	-	+	+	-	+	+	-	-	-
3.	*Clavariopsis aquatica*	+++	++	++	++	+	+	+	+	+	-	+	+
4.	*Dimorphospora foliicola*	+++	++	-	-	-	-	++	+	-	-	-	-
5.	*Heliscella stellatacula*	+++	++	+	+	-	-	-	-	-	-	-	-
6.	*Heliscus lugdunensis*	++	++	+++	-	+	-	+	-	-	-	-	-
7.	*Lemonniera cornuta*	+++	+++	-	-	-	++	-	++	+	+	+	+
8.	*Lunulospora curvula*	+	++	+++	+	++	+	+	+	+	-	-	-
9.	*L. cymbiformis*	+	++	-	+++	++	-	-	+	+	-	-	+
10.	*Tetrachaetum elegans*	+++	+++	++	++	-	-	-	+	-	-	-	-
11.	*Tetracladium marchalianum*	++	+	++	-	-	++	-	+	+	-	-	-
12.	*Alatospora pulchella*	-	+++	+++	-	-	-	-	-	-	-	-	-
13.	*Camposporium pellucidum*	-	++	++	+	-	-	-	-	-	-	-	-
14.	*Cylindrocarpon aquaticum*	-	++	++	++	-	-	+	+	+	-	-	-
15.	*Speiropsis scopiformis*	-	++	+++	++	-	-	+	-	-	-	-	-
16.	*Triscelophorus acuminatus*	-	+++	-	++	++	-	-	-	-	-	-	-
17.	*T. monosporus*	-	+++	++	++	+++	++	+	+	+	+	+	+
18.	*Campylospora chaetocladia*	-	-	++	++	-	+++	++	-	+	+	-	-
19.	*Pestalotiopsis submersus*	-	-	+++	-	++	-	+	-	-	-	-	-
20.	*Setosynnema isthmosporum*	-	-	+	+++	++	+	-	-	-	-	-	-
21.	*Tetracladium setigerum*	-	-	+++	++	+	-	+	-	-	-	-	-
22.	*Campylospora parvula*	-	-	-	+	-	-	-	-	-	-	-	-
23.	*Flagellospora penicillioides*	-	-	-	++	+++	++	+	+	+	+	+	-
24.	*Lemonniera pseudofloscula*	-	-	-	-	-	-	+	+	+	+	+	+
25.	*L. terrestris*	-	-	-	-	-	-	+	-	+++	+	-	-
	Total	11	17	17	16	12	9	14	13	13	6	6	6

+ = Less conidial production, ++ = Moderate conidial production, +++ = Abundant conidial production, - = Conidia absent

Table 4: Species Colonization in Oak, Pine and Mixed leaf litter (O, P, M) in different stages of submersion.

S.No.	Species	Collection months 1	2	3	4	5	6	7	8	9	10	11	12
1.	*Alatospora acuminata*	O,P,M	O,P,M	P,M	O,P,M	O,P,M	O	O,P,M	O,P,M	P,M	O,P	P,M	P,M
2.	*A. pulchella*		O,M	M			O						
3.	*Anguillospora crassa*	O	O	O	O		O	O					
4.	*A. longissima*	O,P,M	O,P,M	P,M	O,P	P,M	O,M	O,P	O,P,M	O,M	P		
5.	*Camposporium pellucidum*		O,M	O,M	O,M	O	O	O	O				
6.	*Campylospora chaetocladia*		O	O,M	O,P,M	O,P	O,P,M	O,P,M	O	M	M		
7.	*C. parvula*	O,P	P	O,P	O,M	O,P	O,P	O		P			
8.	*Clavariopsis aquatica*	O,P,M	O,P,M	O,P,M	P,M	O,P,M	O,P,M	O,P,M	O,M	O,P,M	O,P	P,M	P,M
9.	*Cylindrocarpon aquaticum*		M	O,M	M			M	M	M			
10.	*Dimorphospora foliicola*	O,P,M	O,P,M	O		O	O	O,M	P,M			P	
11.	*Flagellospora penicillioides*		P		P,M	P,M	P,M	P,M	P,M	P,M	M	P,M	P
12.	*Heliscella stellatacula*	O,P,M	O,P,M	O,P,M	O,M								
13.	*Heliscus lugdunensis*	O,P,M	O,P,M	O,P,M	O	O,P,M	P	O,P,M	P	P			
14.	*Lemonniera cornuta*	O,P,M	O,P,M				M		P,M	O,P,M	O,P,M	P,M	P,M
15.	*L. pseudofloscula*							M	M	M	M	M	M
16.	*L. terrestris*	O						O,M		M	O,M		
17.	*Lunulospora curvula*	O,M	O,M	O,M	O,M	O,M	O,M	O,M	O,M	O,M	O		
18.	*L. cymbiformis*	O,P,M	O,P,M	O	O,P,M	O,P,M	O,P	O	O,P,M	O,P,M	O,P		P,M
19.	*Pestalotiopsis submersus*			M	O	M	O	M					
20.	*Setosynnema isthmosporum*		O,P	M	O,M	O,P,M	O,P,M	O					
21.	*Speiropsis scopiformis*		O,M	O,P,M	O,P,M	O	P	P,M	O,P	P	O	P	

S.No.	Species	Collection months 1	2	3	4	5	6	7	8	9	10	11	12
22.	*Tetrachaetum elegans*	O,P,M	O,P,M	O,P,M	O,P,M	O,P	O		O,P,M	P			
23.	*Tetracladium marchalianum*	P,M	O,P,M	O,P,M	O,P	O	P,M	O	O,P,M	P,M	O,P		
24.	*T. setigerum*			O,M	O,M	M		M					
25.	*Triscelophorus acuminatus*		O,P,M	O	O,P,M	P,M		O	P	P			
26.	*T. monosporus*		O,P,M	O,P,M	O,M	O,P,M	O,P,M	O,M	O,P,M	O,P,M	O,P,M	M	P,M
	Total	O=13 P=11 M=11	O=19 P=15 M=17	O=17 P=10 M=17	O=18 P=10 M=16	O=14 P=12 M=12	O=15 P=10 M=9	O=16 P=7 M=14	O=11 P=12 M=13	O=6 P=12 M=13	O=9 P=7 M=6	O=0 P=6 M=6	O=0 P=6 M=6

O = Oak leaf litter
P = Pine leaf litter
M = Mixed leaf litter

Table 5: Weight loss in different substrates (Oak, Pine and Mixed) at different stages of decomposition (Initial weight of leaf litter 5g)

Collection months	No. of species			Oak litter		Pine litter		Mixed litter	
	Oak	Pine	Mixed	Weight loss (%)	Monthly weight loss (%)	Weight loss (%)	Monthly weight loss (%)	Weight loss (%)	Monthly weight loss (%)
Initial				0.00	0.00	0.00	0.00	0.00	0.00
1	13	11	11	26.73 ± 1.76	26.73	24.60 ± 1.73	24.60	25.80 ± 3.11	25.80
2	19	15	17	46.13 ± 1.64	26.30	30.53 ± 2.74	6.20	34.60 ± 0.31	11.60
3	17	10	17	48.00 ± 1.36	3.34	33.40 ± 3.82	4.03	36.00 ± 0.31	2.14
4	18	10	16	48.93 ± 1.64	3.84	34.73 ± 3.75	2.10	37.27 ± 0.55	2.10
5	14	12	12	53.27 ± 1.09	7.53	38.87 ± 3.67	6.44	39.53 ± 0.52	3.51
6	15	10	9	55.87 ± 0.37	5.57	41.27 ± 4.28	3.93	40.20 ± 3.22	5.96
7	16	7	14	59.26 ± 0.66	6.30	42.66 ± 4.47	2.38	51.80 ± 1.04	15.14
8	11	12	13	68.33 ± 1.21	23. 30	54.60 ± 1.04	20.60	56.26 ± 1.39	9.54
9	6	12	13	78.40 ± 1.10	31.60	64.20 ± 2.96	21.10	72.80 ± 1.36	37.60
10	9	7	6	86.20 ± 1.78	36.10	70.93 ± 3.40	18.90	76.86 ± 0.81	15.40
11	0	6	6	90.26 ± 1.31	30.43	77.86 ± 1.44	24.13	82.90 ± 0.70	26.08
12	0	6	6	95.80 ± 1.40	56.20	82.66 ± 2.58	21.80	88.73 ± 1.73	34.10