

Chapter 6

Aquatic hyphomycetes (Deuteromycotina) of the Atlantic Maritime Ecozone

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Abstract: Aquatic hyphomycetes are mitosporic states of ascomycetes (Phylum Ascomycota) and basidiomycetes (Phylum Basidiomycota). They occur most commonly on deciduous leaves that have fallen into streams, and perform a vital role conditioning this plant detritus for consumption by stream invertebrates. Most investigations of the community structure and distribution of this group have been based on identifying species by the shape of their conidia. Conidial morphology, however, has been strongly constrained by natural selection to facilitate adherence to the preferred substrate, deciduous leaves. Convergent evolution has resulted in two dominant shapes, tetra- and sigmoid. Unequivocal identification based on detached conidia is therefore not always possible. In this chapter we compile all reports of aquatic hyphomycetes from the Atlantic Maritime Ecozone of eastern Canada, incorporating our own unpublished collections. Records for 126 species and two varieties are presented. We also provide photomicrographs or drawings for 62 aquatic hyphomycete species, two varieties, and two morphotypes.

Résumé : Les hyphomycètes aquatiques sont des états mitosporiques d'ascomycètes (phylum Ascomycota) et de basidiomycètes (phylum Basidiomycota). Ils surviennent le plus souvent sur des feuilles caduques tombées dans les cours d'eau, et jouent un rôle vital dans le conditionnement des débris végétaux pour leur consommation par les invertébrés. La plupart des études de la structure et de la répartition des communautés de ce groupe ont été fondées sur l'identification des espèces par la forme de leurs conidies. La morphologie des conidies, cependant, a été fortement restreinte par la sélection naturelle en vue de faciliter l'adhérence aux feuilles caduques, le substrat préférentiel. L'évolution convergente a mené à deux formes dominantes, tétra- et sigmoïde. Une identification sans équivoque fondée sur des conidies détachées n'est donc pas toujours possible. Dans ce chapitre, nous faisons la compilation de tous les hyphomycètes aquatiques répertoriés dans l'écozone maritime de l'Atlantique de l'est du Canada, y compris de nos collections non publiées. Nous présentons 126 espèces et deux variétés. Nous avons aussi compilé toutes les publications ainsi que nos collections non publiées sur les hyphomycètes aquatiques de l'écozone maritime de l'Atlantique (un total de 126 espèces et de deux variétés), et fournissons ici des photomicrographies ou des schémas relatifs à 62 espèces de hyphomycètes aquatiques, deux variétés et deux morphotypes.

Introduction

Aquatic hyphomycetes, also known as freshwater hyphomycetes (Nilsson 1964), amphibious hyphomycetes (Michaelides and Kendrick 1978), or Ingoldian Fungi (Webster and Descals 1981), belong to the Kingdom Fungi. They are mitosporic (conidial, anamorphic, asexual, “imperfect”) states of ascomycetes (Phylum Ascomycota) and basidiomycetes (Phylum Basidiomycota). They occur most commonly on deciduous leaves that have fallen into streams, where they perform a vital role in conditioning plant detritus for consumption by stream invertebrates. In this chapter, we review all reports of aquatic hyphomycetes from the Atlantic Maritime Ecozone (AME), a region covering the provinces of New Brunswick,

Nova Scotia, and Prince Edward Island, and Îles de la Madeleine, part of the the Eastern Townships, and the Gaspé region of Quebec.

Aquatic hyphomycetes are relatively poorly known; connections between asexual anamorph and sexual teleomorph life-history stages have been documented in less than 10% of described taxa (Webster 1992). ~~Connections are known in less than 10% of described taxa (Webster 1992).~~ Many aquatic hyphomycetes may have lost the teleomorph at an early stage in their evolution, and subsequently continued their speciation. The polyphyletic origin of the group is evident from genetic relationships (shown in pure culture) to several classes of ascomycetes, including Dothideomycetes

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(“loculoascomycetes”), Leotiomycetes, Orbiliomycetes, and Pezizomycetes (“discomycetes”) and Sordariomycetes (“pyrenomycetes”) and to three classes of basidiomycetes, Microbotryomycetes, Classiculomycetes, and Agaricomycetes. A relatively high proportion of aquatic hyphomycetes possess microconidial states with nongerminating phialoconidia, which are regarded as spermatia (andromorphs). According to J. Webster (pers. comm., 1990), such states indicate the probable presence of the teleomorph stage.

The currently accepted custom is not to subject mitospore fungi to the full hierarchical system with orders and families. Genus, species, and lower categories only are used.

Many aquatic hyphomycetes form tetradiate conidia (four diverging arms); some have sigmoid conidia (long, wormlike, generally curved in more than one plane); a minority have spores of a more conventional shape. This suggests parallel evolution; today, it is commonly accepted that the tetradiate and, to a lesser extent, the sigmoid shape facilitate conidial attachment to leaves and other substrates (Webster 1959; Read et al. 1992).

Two members of this group were described from the terrestrial environment in 1880 (Saccardo 1880; Hartig 1880); de Wildeman (1893, 1894, 1895) found four more species in ponds, ditches, and marshy areas. The preferred habitat of these fungi, dead leaves in streams and rivers, was discovered by Ingold (1942). Following this breakthrough, reports on the occurrence, and discoveries of new species, multiplied rapidly. Among the more comprehensive surveys of specific regions are those of California (Ranzoni 1953), Japan (Tubaki 1957), the eastern United States (Petersen 1962, 1963*a, b*), Scandinavia (Nilsson 1964; Bråthen 1983, 1984), Ukraine and the former Soviet Union (Dudka 1974, 1985), and Puerto Rico (Santos-Flores and Betancourt-López 1997). Today, over 300 species of this ecological group have been described. This rapid expansion of taxonomic study has firmly established that the conidial shape is largely a product of convergent evolution. Very similar tetradiate and sigmoid forms have evolved in taxa as phylogenetically distant as ascomycetes and basidiomycetes. For example, *Anguillospora crassa* Ingold (ascomycetes) vs. *Anguillomyces acadensis* Marvanová & Bärli. (basidiomycetes) and *Articulospora* spp. (ascomycetes) vs. *Crucella subtilis* Marvanová & Suberkr. (basidiomycetes). In many taxa, especially in those with sigmoid conidia, the conidiogenesis must be seen for unequivocal identification, preferably in pure culture. Some taxa (e.g., *Colispora elongata* Marvanová and unbranched conidia of *Pachycladina mutabilis* Marvanová) are difficult to distinguish even when seen on conidiophores on leaves. The conidiogenesis switches between percurrent and sympodial proliferation of the conidiophore in both, but the dark grey colony in *Colispora* and the whitish colony with a rosy hue in *Pachycladina* are quite distinct.

Initially, the taxonomy of aquatic hyphomycetes seemed very straightforward, owing to the very distinct conidial morphology and conidiogenesis. Several taxa were described on the basis of material from nature, ignoring a great deal of in-

formation only available from pure culture (colony character, possible microconidial state, chlamydoconidia, hyphopodia, etc.). Small differences in conidial shape were considered morphological variants of one taxon. For example, *Brachiosphaera tropicalis* Nawawi was repeatedly misidentified as *Actinosporella megalospora* (Ingold), which is the anamorph of the pezizalean discomycete *Miladina lechithina* (R.C. Cooke) Svrček. and follows more or less its distribution in the temperate climate. *Brachiosphaera* (without known teleomorph) appears in the tropics and subtropics. Another example is *Margaritispora aquatica* Ingold, with angulose pearly conidia. It has often been reported from ecological studies based on water filtration. *Goniopila monticola* (Dyko), with almost identical conidia overlapping in size, has never been reported from such studies. It may nevertheless be quite common and has repeatedly been isolated from streams in the AME.

Similarly, the relatively obscure conidial basidiomycete *Jaculispora submersa* H.J. Huds. & Ingold, common in tropical and subtropical streams, has been confused with *Naiadella fluitans* Marvanová & Bärli., distributed from temperate to warm climate. It is quite possible that they may co-occur at some locations.

By the late 1960s, much was known about the taxonomy, biology, and ecology of aquatic hyphomycetes (Webster and Descals 1981; Bärlocher 1992*a*). Nevertheless, few stream ecologists were probably aware of their existence. This changed with the recognition that typically 50–99% of the food available to stream communities is derived from allochthonous plant materials, primarily deciduous leaves, needles, and branches of riparian trees and shrubs (Hynes 1975). This detritus is generally not acceptable to its main consumers, stream invertebrates, until it has been colonized by fungi (Triska 1970; Kaushik and Hynes 1971). Aquatic hyphomycetes thus form an intermediate trophic level between leaves and leaf-shredders; the latter may benefit from the addition of nutrient-rich fungal cells to a relatively poor food source, as well as from conversion of recalcitrant plant polysaccharides into more easily digested subunits (Bärlocher 1985; Suberkropp 1992). Most aquatic hyphomycetes produce a rich variety of cell-wall-degrading enzymes, such as pectinases, cellulases, and hemicellulases (Chamier 1985; Zemek et al. 1985).

Fungal biomass and growth in ecosystems are difficult to measure. Initially, fungal colonization of leaves in streams was estimated by measuring stained hyphae in “bleached” leaves (Bärlocher and Kendrick 1974). Later, ATP was used as an index of fungal biomass (Suberkropp et al. 1976; Rosset et al. 1982); however, this compound also occurs in bacteria, algae, and protozoa, all of which are undoubtedly present on dead leaves. More recently, ergosterol, a sterol essentially restricted to the intact membranes of Eumycota, has become the indicator molecule of choice (Newell et al. 1989; Gessner 1997). Measuring incorporation of ¹⁴C-labelled acetate into ergosterol has allowed estimates of fungal growth rate and production (Newell and Fallon 1991; Gessner 1997).

The relative importance of bacteria and fungi has been

compared by determining leaf mass loss in the presence of selective antibiotics (e.g., Triska 1970; Kaushik and Hynes 1971), by counting cells using light or epifluorescence microscopy (Iversen 1973; Findlay and Arsuffi 1989), or by measuring ergosterol concentration and its rate of synthesis (for review, see Gessner 1997). The majority of published studies show that fungal biomass and productivity generally outweigh bacterial numbers by a ratio of at least 9:1 during the initial phase of decay (Gessner 1997). Fungal mycelia can account for up to 17% of detrital leaf mass. In the first published stream-wide survey, Suberkropp (1997) estimated that annual leaf-associated fungal production per area is of the same order of magnitude as that of bacteria and macroinvertebrates. As much as 50% of this production can be channelled into the formation of conidia (Findlay and Arsuffi 1989; Sridhar and Bärlocher 2000), which are released and carried downstream by the current. Conidia trapped in foam (Ingold 1942, 1975), concentrated from the water column by filtration (Iqbal and Webster 1973*a, b*), or collected from leaves aerated in water in the laboratory (Bärlocher 1982) have routinely been used to characterize fungal communities of entire streams, their seasonal changes, or fungal successions during leaf decay. Unfortunately, unequivocal identification of aquatic hyphomycetes often requires observation of conidiogenesis in pure cultures (Descals 1997).

Ergosterol measurements do not reveal the relative contributions of individual species; counting and identifying conidia released from incubated leaves gives no information on the spatial distribution of the mycelia (which may give important clues on competition among species, and may determine food selection by leaf-shredders (Rong et al. 1995; Suberkropp 1992)). Both shortcomings may be overcome by using fluorescently labelled monoclonal antibodies (MAb) combined with quantitative enzyme-linked immunosorbant assays (ELISA; Bermingham et al. 1995–1997). Another promising method is fluorescent *in situ* hybridization (FISH; Baschien et al. 2001; McArthur et al. 2001). It is based on “phylogenetic stains” (DeLong et al. 1989), fluorescently labelled oligonucleotides complementary to unique, species or group-specific sequences. They are designed to hybridize to target ribosomal RNA within intact cells. Since rRNAs have regions of variable sequence preservation, it is possible to design probes that are kingdom, genus, or species specific.

Molecular techniques also allow estimates of the diversity of fungal communities without the need to examine reproductive structures (conidia and conidiophores in aquatic hyphomycetes). DNA is extracted from the substrate and a gene present in all members of the community (generally a section of rRNA) is amplified. Denaturing gradient gel electrophoresis (DGGE; Muyzer et al. 1993; May et al. 2001) separates the amplified fragments. Providing the gene includes a region that varies among the species, the fragments will show up as distinct bands on a DGGE gel. The number of bands corresponds to the minimum number of mycelia that differ in the particular gene that has been amplified. However, without knowing the

sequences of the individual bands on the gel and those of the fungal species that might be present, the technique does not reveal the composition of the community.

A related approach uses a fluorescently labelled primer (terminal restriction fragment length polymorphism = T-RFLP; Liu et al. 1997). The amplified DNA fragments are digested with a number of restriction enzymes, and the lengths of the labelled ends are measured in a DNA sequencer. Again, provided the strains present in the community show sufficient variability in the chosen gene, the number of different fragments (ribotypes) gives a minimum estimate of overall diversity. Both DGGE and T-RFLP have been applied successfully at Mount Allison University (Nikolcheva et al. 2003).

Molecular techniques have the potential to revolutionize our understanding of the ecology and evolution of aquatic hyphomycetes (Schierwater et al. 1994; Bärlocher 2007); to date, only three studies looking at variations within species have been published (Peláez et al. 1996; Charcosset and Gardes 1999; Laitung et al. 2004).

Human activities often lead to extinction of species; this may jeopardize vital ecological functions. Aquatic hyphomycete communities are most likely to be affected by changes in types and amounts of available substrates (logging, replacing native forests by plantations) and pollution (acid precipitation, organic pollution, agricultural fertilizers, heavy metals, biocides). Some work has been done on potential connections between diversity and ecological functions in aquatic hyphomycetes and how they might be affected by human activities (Raviraja et al. 1998; Garnett et al. 2000; Sridhar et al. 2001; Bärlocher and Graça 2002; Bärlocher and Corkum 2003; Dang et al. 2005; Duarte et al. 2006; Raviraja et al. 2006), but this is clearly an aspect in need of further study.

Taxonomic diversity in the AME

An accurate account of biodiversity depends on exhaustive, representative sampling procedures and reliable identification of observed organisms. There are significant difficulties with both aspects in the case of aquatic hyphomycetes.

There is little doubt that in most temperate streams bordered by deciduous forests, fungal activity is strongly seasonal and correlated with the annual leaf fall. As a result, numbers of conidia per volume of stream water fluctuate by 2–3 orders of magnitude during an annual cycle. Conidia ~~volume reach~~ a maximum 4–12 weeks after leaf fall; a second, smaller peak is sometimes observed shortly after snow-melt (Bärlocher 1992*a, b*). Common techniques to survey fungal diversity include examination of naturally occurring foam (Ingold 1975; Descals 1997) or filtration of stream water (Iqbal and Webster 1973*a, b*). Foam traps small particles, and is often full of conidia of aquatic hyphomycetes. However, this entrapment is selective. Spores with complex branching are over-represented, while sigmoid spores are relatively scarce (Iqbal and Webster 1973*a*; Lindsey and Glover 1976). This bias is less pronounced when a sample of stream water is filtered and

spores on the filter are counted and identified; however, since branched conidia are more likely to settle on substrates (which will remove them from the water column), these counts again are likely to distort spore production by individual species.

For accurate comparisons of different communities, or their seasonal or successional trends, sample sizes must remain constant throughout the study (Krebs 1999). With aquatic hyphomycetes, the sample size could be defined as the volume of filtered water, or as the cumulative number of spores that are identified. Very few studies in aquatic mycology have considered this aspect (exceptions: Gönczöl et al. 2001, Bärlocher and Graça 2002).

A second difficulty with foam or filtered water samples is the reliance on spore morphology. While this allows unequivocal identification in many species, observation of conidium production in pure cultures is necessary in others. Establishing these cultures, and inducing them to sporulate, can be time-consuming, which will lower the sample size that can be processed. In the future, molecular techniques, noted previously, may allow quicker and more reliable identifications.

Conidia trapped in foam or suspended in the water column may have been washed in from the soil or have dripped in from overhanging trees (Bärlocher 1992*a, b*). To establish the involvement of a particular species in breakdown processes, the species has to be observed on a substrate or isolated from it. While most species can colonize a broad range of deciduous leaves, there is nevertheless some evidence of substrate preference. In particular, wood and grass blades bear some unique species (Gulis 2001). A complete inventory of the fungal community would therefore require scrutiny of all substrates occurring in a stream.

In view of these potential difficulties, probably any relatively pristine stream supports taxa that are new to science. Streams in the AME are no exception, even though a considerable amount of research into aquatic hyphomycetes has been conducted in the region. However, the primary emphasis of this research has been on fungal ecology. Even when entire fungal communities were investigated, the objectives were generally not to establish complete species lists, but to compare communities in different streams and relate observed differences to physical, chemical, or biological factors. This, and the general reliance on conidia, necessitated a conservative approach: only clearly distinct conidia were taken into account, which will underestimate total diversity (the reliance on conidia will also make some misidentifications unavoidable). During two visits to Mount Allison University, L.M. undertook extensive sampling of many streams; the primary goal was to isolate and describe new and less well-known taxa. Since each visit was restricted to a few weeks to months, and many streams could only be visited once or twice, these studies did not result in complete lists of the fungi occurring in any given stream.

Overview of published studies

The first systematic survey of streams in New Brunswick and Nova Scotia was published by Bärlocher (1987). It was a

continuation of similar studies conducted in Europe (Bärlocher and Rosset 1981; Wood-Eggenschwiler and Bärlocher 1983), with the main objective to relate species numbers to stream chemistry (primarily pH, Ca, and alkalinity). The presence of species was based on conidia identified in foam samples (six samples at 2-month intervals). On each sampling date, 5–10 × 10³ conidia were scanned. The emphasis was on relatively distinct, easily identifiable conidia.

The only other extended survey in the AME consisted of monthly samples during 5 consecutive years (Bärlocher 2000). On each sampling date 5 samples of 0.5–1 L of stream water were filtered, and conidia trapped on the filter were counted and identified. Again, the main emphasis was on distinct, easily identifiable conidia, and how the proportions of these types fluctuated through the year and between years. However, a parallel study in the same stream investigated colonization of introduced maple leaves; many of the identifications based on loose conidia were confirmed by observing the same species sporulating on these leaves (Garnett et al. 2000).

In addition to these two surveys, a number of ecologically oriented investigations have added to the list of aquatic hyphomycetes from Nova Scotia and New Brunswick streams. Some of the studies looked at previously ignored substrates (e.g., *Fontinalis antipyretica* L. ex Hedw., Bryophyta, Sridhar et al. 2000; roots of riparian trees, Sridhar and Bärlocher 1992*a, b*); others concentrated on poorly studied, stream-related habitats (hyporheic zone, Bärlocher and Murdoch 1989; terrestrial sites near streams, Sridhar and Bärlocher 1993); in a third group, the objectives ranged from exploring the effects of drying or freezing leaves before stream exposure (Bärlocher 1992*d*), or establishing the influence of inorganic nutrients on fungal colonization (Sridhar and Bärlocher 2000), to comparing fungal biomass accumulation and spore production on leaves and wood (Maharning and Bärlocher 1996).

Finally, a series of publications resulted from two visits by L.M. to Mount Allison University (Marvanová and Bärlocher 1988, 1989, 1998*a–c*, 2000, 2001; Marvanová et al. 1997). As mentioned earlier, the main focus was on the isolation of new or less well-known fungi, and on confirming identifications based on detached conidia in foam or the water column. Many identifications not incorporated into these papers are presented in Table 1 as L.M. 1987 or L.M. 1994 (unpubl.).

The taxonomic information in these papers is based on pure culture studies, which is the most, and sometimes the only, reliable method of identification. On the other hand, this very labour-intensive approach places practical limits on the amount of information that can reasonably be gained concerning the fungal diversity within a stream.

Table 1 compiles all published records of aquatic hyphomycetes from water bodies or their surroundings in the AME. Voucher specimens for L.M.'s pure cultures (living culture and (or) microscopic preparation of conidiogenous structures) are preserved in the Czech Collection of Microorganisms in Brno, Czech Republic. Some identifications based solely on conidia must be considered tentative. Table 2 lists

Table 1. Aquatic hyphomycete species recorded from streams in the Maritime Atlantic Ecozone. Method used for identification: F, conidia in foam; W, conidia filtered from water; S, conidia filtered from substrate; substrate+, conidiogenesis seen on substrate; P, pure culture.

Species	Location ^a	Method	Source	Reference
<i>Actinosporella megalospora</i> (Ingold) Descals & Marvanová (1999)	SG	F		Bärlocher 1987 (as <i>Actinospora megalospora</i> Ingold (1952))
	LKL	F		Bärlocher 1987 (as <i>A. megalospora</i>)
	AC	F		Bärlocher 1987 (as <i>A. megalospora</i>)
	BB	S	Leaves	Sridhar and Bärlocher 1993 (as <i>A. megalospora</i>)
	BC	P	Wood	L.M. 1987 (unpubl.), from ascospores of teleomorph
<i>Alatospora acuminata</i> Ingold (1942)	GP	F		Ingold 1960
	SG	F		Bärlocher 1987
		P	Foam	L.M. 1987, unpubl.
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Bärlocher 1992c
		S	Leaves	Sridhar and Bärlocher 1993
	AC	F		Bärlocher 1987
		S	Leaves	Sridhar and Bärlocher 1993
		S	Moss	Sridhar et al. 2000
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
		P	Foam	L.M. 1994, unpubl.
		NAR	P	Foam
	FB	P	Foam	L.M. 1994, unpubl.
	ChRR	P	Foam	L.M. 1994, unpubl.
<i>A. constricta</i> Dyko (1978)	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Sridhar and Bärlocher 1993
	AC	F		Bärlocher 1987
		S	Leaves	Sridhar and Bärlocher 2000
		S	Moss	Sridhar et al. 2000
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Marvanová and Bärlocher 2001
		F		Marvanová and Bärlocher 2001
		ArsB	F	Marvanová and Bärlocher 2001
	ChRR	P	Foam	Marvanová and Bärlocher 2001 (illust.)
<i>A. flagellata</i> (J. Gönczöl) Marvanová (1980)	SG	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
<i>A. pulchella</i> Marvanová (1977)	CA	W		Bärlocher 2000
		S	Leaves	Garnett et al. 2000
		P	Foam	L.M. 1994, unpubl.
<i>Anguillomyces acadensis</i> Marvanová & Bärl. (2000)	RPWB	F		Marvanová and Bärlocher 2000 (illust.)
	ArsB	P	Foam	Marvanová and Bärlocher 2000 (illust.)

Species Diversity in the Atlantic Maritime Ecozone

Table 1 (continued).

Species	Location ^a	Method	Source	Reference	
<i>Anguillospora crassa</i> Ingold (1958)	GP	F		Ingold 1960	
	SG	F		Bärlocher 1987	
	LKL	F		Bärlocher 1987	
	LKR	F		Bärlocher 1987	
	BB	F		Bärlocher 1987	
	AC	S		Leaves	Sridhar and Bärlocher 1993
		F			Bärlocher 1987
		P		Foam	L.M. 1987, unpubl.
		S		Leaves	Sridhar and Bärlocher 2000
		S		Moss	Sridhar et al. 2000
	TMB	F		Bärlocher 1987	
	SC	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
	TC	F		Bärlocher 1987	
	CCB	F		Bärlocher 1987	
	CA	W			Bärlocher 2000
	SREB	P		Foam	L.M. 1994, unpubl.
	WF	P		Wood	L.M. 1994 (unpubl.), from ascospores of teleomorph
	<i>A. filiformis</i> Greath. (1961)	BB	S	Tree roots	Sridhar and Bärlocher 1992a
S			Tree roots	Sridhar and Bärlocher 1992b	
P			Tree roots	Sridhar and Bärlocher 1992b	
S			Leaves	Bärlocher 1992c	
LR		S	Leaves		Sridhar and Bärlocher 1993
		P			Miersch et al. 1997
AC		S	Leaves		Sridhar and Bärlocher 2000
		S	Moss		Sridhar et al. 2000
		P	Foam		L.M. 1987, 1994, unpubl.
CA		W			Bärlocher 2000
		S	Leaves+		Garnett et al. 2000
		P	Foam		L.M. 1994, unpubl.
		HgwR	P	Foam	L.M. 1987, unpubl.
DitRP	P	Foam	L.M. 1987, unpubl.		
WF	P	Foam	L.M. 1994, unpubl.		
<i>Anguillospora furtiva</i> J. Webster & Descals (1999)	LKN	P	Foam	L.M. 1994, unpubl.	
	PB	P	Wood	L.M. 1994 (unpubl.), from ascospores of teleomorph	
<i>A. longissima</i> (Sacc. & Syd.) Ingold (1942)	GP	F		Ingold 1960	
	SG	F		Bärlocher 1987	
	LKL	F		Bärlocher 1987	
	LKR	F		Bärlocher 1987	
	BB	F		Bärlocher 1987	
	AC	F			Bärlocher 1987
		S		Leaves	Bärlocher 1987
		S		Moss	Sridhar et al. 2000
		TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
	TC	F		Bärlocher 1987	
	CCB	F		Bärlocher 1987	
	CA	W			Bärlocher 2000
		S		Leaves+	Garnett et al. 2000
		P		Foam	L.M. 1994, unpubl.
<i>A. rosea</i> J. Webster & Descals (1999)	NAR	P	Foam	L.M. 1994, unpubl.	
	FB	P	Foam	L.M. 1994, unpubl.	
	ChRR	P	Foam	L.M. 1994, unpubl.	
	OMB	P	Foam	L.M. 1994, unpubl.	
	CA	P	Foam	L.M. 1994, unpubl.	

Table 1 (continued).

Species	Location ^a	Method	Source	Reference	
<i>Arborispora dolichovirga</i> K. Ando (1986)	BB	F		Bärlocher 1987 (as <i>Magdalaena monogramma</i> G. Arnaud (1952))	
	AC	F		Bärlocher 1987 (as <i>M. monogramma</i>)	
	WB	F		Bärlocher 1987 (as <i>M. monogramma</i>)	
	CA	W		Bärlocher 2000 (as <i>M. monogramma</i>)	
<i>A. paupera</i> Marvanová & Bärlocher (1989)		P	Foam	Marvanová and Bärlocher 2001 (illustr.)	
	AC	P	Foam	Marvanová and Bärlocher 1989 (illustr.)	
	BB	S	Leaves	Sridhar and Bärlocher 1993	
<i>Arbusculina irregularis</i> (R.H. Petersen) Marvanová & Descals (1987)		S	Leaves	Sridhar and Bärlocher 2000	
	LKR	P	Foam	L.M. 1987, unpubl.	
<i>A. moniliformis</i> (Descals) Marvanová & Descals (1987)	AC	F		Bärlocher 1987 (as <i>Dendrospora moniliformis</i> Descals (1983))	
<i>Arcispora bisagittaria</i> Marvanová & Bärlocher (1998)	CA	P	Foam	Marvanová and Bärlocher 1998 (illustr.)	
<i>Articulospora atra</i> Descals (1982)	BB	S	Tree roots	Sridhar and Bärlocher 1992b	
	CA	W		Bärlocher 2000	
		S	Leaves	Garnett et al. 2000	
	SG	P	Foam	L.M. 1987, unpubl.	
	AC	P	Foam	L.M. 1987, unpubl.	
	HgWR	P	Foam	L.M. 1987, unpubl.	
	DitRP	P	Foam	L.M. 1987, unpubl.	
	GA	P	Foam	L.M. 1994, unpubl.	
	<i>A. proliferata</i> A. Roldán & W.J.J. van der Merwe (1990)	BB	S	Tree roots	Sridhar and Bärlocher 1992b (as <i>A. antipodea</i> Roldan & Honrubia ined.)
		CA	W		Bärlocher 2000 (as <i>A. antipodea</i>)
			S	Leaves	Garnett et al. 2000 (as <i>A. antipodea</i>)
<i>A. tetracladia</i> Ingold (1942)	AC	S	Leaves	Sridhar and Bärlocher 2000 (as <i>A. antipodea</i>)	
		S	Moss	Sridhar et al. 2000 (as <i>A. antipodea</i>)	
	GP	F		Ingold 1960	
	BB	S	Tree roots	Sridhar and Bärlocher 1992a	
		S	Tree roots	Sridhar and Bärlocher 1992b	
		P	Tree roots	Sridhar and Bärlocher 1992b	
		P	Foam	L.M. 1994, unpubl.	
		S	Leaves	Bärlocher 1992c	
		S	Leaves	Sridhar and Bärlocher 1993	
	CS	P		Miersch et al. 1997	
	SG	P	Foam	L.M. 1987, 1994, unpubl.	
	AC	S	Leaves	Sridhar and Bärlocher 2000	
		P	Foam	L.M. 1987, unpubl.	
		S	Moss	Sridhar et al. 2000	
		CA	W		Bärlocher 2000
	S	Leaves+	Garnett et al. 2000		
	CB	P	Foam	L.M. 1994, unpubl.	
	ChR	P	Foam	L.M. 1994, unpubl.	
	CHRR	P	Foam	L.M. 1994, unpubl.	
	RW	P	Foam	L.M. 1994, unpubl.	
<i>Calcarispora hiemalis</i> Marvanová & Marvan (1963)	ChRR	P	Foam	Marvanová and Bärlocher 2001 (illustr.)	
	CA	P	Foam	Marvanová and Bärlocher 2001	
<i>Campylospora chaetocladia</i> Ranzoni (1953)	CA	W		Bärlocher 2000	
<i>C. parvula</i> Kuzuha (1973)	LKR	F		Bärlocher 1987	
	TMB	F		Bärlocher 1987	
	CA	W		Bärlocher 2000	
<i>Casaresia sphagnorum</i> Gonz. Frag. (1920)	GP	F		Ingold 1960 (as <i>Ankistrocladium fuscum</i> Perrott (1960))	
<i>Cladoconidium articulatum</i> Bandoni & Tubaki (1985)	AC	S	Leaves	Sridhar and Bärlocher 2000	
	BIB	P	Foam	Marvanová and Bärlocher 2001 (illustr.)	
<i>Clathrosphaerina zalewskii</i> Beverw. (1951)	BIB	P	Foam	L.M. 1994, unpubl.	

Species Diversity in the Atlantic Maritime Ecozone

Table 1 (continued).

Species	Location ^a	Method	Source	Reference	
<i>Clavariopsis aquatica</i> De Wild. (1895)	GP	F		Ingold 1960	
	SG	F		Bärlocher 1987	
	LKL	F		Bärlocher 1987	
	LKR	F		Bärlocher 1987	
	SC	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
	TC	F		Bärlocher 1987	
	AC	F		Bärlocher 1987	
			S	Leaves	Sridhar and Bärlocher 2000
			S	Moss	Sridhar et al. 2000
			P	Foam	L.M. 1987, unpubl.
	BB		S	Tree roots	Sridhar and Bärlocher 2000
			S	Leaves	Bärlocher 1992c
			S	Leaves	Sridhar and Bärlocher 1993
		CA	W		Bärlocher 2000
<i>Clavatospora longibrachiata</i> (Ingold) Marvanová & Sv. Nilsson (1971)		S	Leaves+	Garnett et al. 2000	
	GP	F		Ingold 1960	
	SG	F		Bärlocher 1987	
	SG	P	Foam	L.M. 1994, unpubl.	
	LKL	F		Bärlocher 1987	
	LKR	F		Bärlocher 1987	
	BB	F		Bärlocher 1987	
			S	Leaves	Bärlocher 1992c
			S	Leaves	Sridhar and Bärlocher 1993
	AC	F		Bärlocher 1987	
			S	Leaves	Sridhar and Bärlocher 2000
			S	Moss	Sridhar et al. 2000
	TMB	F		Bärlocher 1987	
	SC	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
	TC	F		Bärlocher 1987	
	CCB	F		Bärlocher 1987	
	CA	W		Bärlocher 2000	
<i>Crucella subtilis</i> Marvanová & Suberkr. (1990)		S	Leaves+	Garnett et al. 2000	
	BB	S	Leaves	Bärlocher 1992c	
		S	Leaves	Sridhar and Bärlocher 1993	
	CA	W		Bärlocher 2000	
	AC	S	Moss	Sridhar et al. 2000	
<i>Cryptococcus aquaticus</i> (E.B.G. Jones & Sloof) Rodr. Mir. & Weijman (1988)	LKL	F		Bärlocher 1987 (as <i>Candida aquatica</i> E.B. Jones & Slooff (1966))	
	TC	F		Bärlocher 1987 (as <i>C. aquatica</i>)	
	BB	S	Leaves	Sridhar and Bärlocher 1993 (as <i>C. aquatica</i>)	
	CA	W		Bärlocher 2000 (as <i>C. aquatica</i>)	
		S	Leaves	Garnett et al. 2000 (as <i>C. aquatica</i>)	
<i>Culicidospora aquatica</i> R.H. Petersen (1960)	GP	F		Ingold 1960	
	SG	F		Bärlocher 1987	
	LKR	F		Bärlocher 1987	
	BB	F		Bärlocher 1987	
		S	Leaves	Bärlocher 1992c	
	AC	F		Bärlocher 1987	
		P	Foam	L.M. 1987, unpubl.	
		S	Leaves	Sridhar and Bärlocher 2000	
		S	Moss	Sridhar et al. 2000	
	TMB	F		Bärlocher 1987	
	SC	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
	CCB	F		Bärlocher 1987	
	CA	W		Bärlocher 2000	
		S	Leaves	Garnett et al. 2000	

Table 1 (continued).

Species	Location ^a	Method	Source	Reference	
<i>C. gravida</i> R.H. Petersen (1963)	SG	F		Bärlocher 1987	
	LKL	F		Bärlocher 1987	
	LKR	F		Bärlocher 1987	
	BB	F		Bärlocher 1987	
		S	Leaves	Sridhar and Bärlocher 1993	
	AC	F		Bärlocher 1987	
		P	Foam	L.M. 1987, unpubl.	
	TMB	F		Bärlocher 1987	
	SC	F		Bärlocher 1987	
	TC	F		Bärlocher 1987	
	CA	W		Bärlocher 2000	
		S	Leaves	Garnett et al. 2000	
	<i>Cylindrocarpon aquaticum</i> (S.V. Nilsson) Marvanová & Descals (1987)	BB	S	Tree roots	Sridhar and Bärlocher 1992b
		P	Tree roots	Sridhar and Bärlocher 1992b	
<i>Cylindrotrichum helisciforme</i> Marvanová (1979)	SG	F		Bärlocher 1987	
	TMB	F		Bärlocher 1987	
	CCB	F		Bärlocher 1987	
<i>Dactylella microaquatica</i> Tubaki (1957)	BB	S	Leaves	Sridhar and Bärlocher 1993	
<i>Dendrospora erecta</i> Ingold (1943)	GP	F		Ingold 1960	
	SG	F		Bärlocher 1987	
	LKL	F		Bärlocher 1987	
	BB	F		Bärlocher 1987	
	AC	F		Bärlocher 1987	
	TMB	F		Bärlocher 1987	
	SC	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
	CA	W		Bärlocher 2000	
	ChRR	P	Foam	L.M. 1994, unpubl.	
	<i>D. fastuosa</i> Descals & J. Webster (1980)	SG	F		Bärlocher 1987
		TMB	F		Bärlocher 1987
		CA	W		Bärlocher 2000
<i>D. fusca</i> Descals & J. Webster (1980)	CA	W		Bärlocher 2000	
<i>D. nana</i> Descals & J. Webster (1980)		S	Leaves+	Garnett et al. 2000	
	LKL	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
	CA	W		Bärlocher 2000	
	BB	S	Leaves	Sridhar and Bärlocher 1993	
	AC	S	Leaves	Sridhar and Bärlocher 2000	
		S	Moss	Sridhar et al. 2000	
<i>D. tenella</i> Descals & J. Webster (1980)		P	Foam	L.M. 1987, unpubl.	
	SG	F		Bärlocher 1987	
		P	Foam	L.M. 1987, unpubl.	
	BB	F		Bärlocher 1987	
	AC	P	Foam	L.M. 1987, unpubl.	
	CB	P	Foam	L.M. 1994, unpubl.	
	GA	P	Foam	L.M. 1994, unpubl.	
	ChR	P	Foam	L.M. 1994, unpubl.	
	<i>Dimorphospora foliicola</i> Tubaki (1958)	BB	S	Leaves	Bärlocher 1992c
		CA	W		Bärlocher 2000
<i>Dwayaangam cornuta</i> Descals (1982)	BB	F		Bärlocher 1987	
		S	Leaves	Sridhar and Bärlocher 1993	
	CA	W		Bärlocher 2000	
<i>Fibulotaeniella canadensis</i> Marvanová & Bär. (1988)	SG	P	Foam	Marvanová and Bärlocher 1988	
	AC	P	Foam	Marvanová and Bärlocher 1988 (illust.)	
	HgWR	P	Foam	Marvanová and Bärlocher 1988	
	BC	P	Foam	L.M. 1994, unpubl.	
<i>Filosporella pinguis</i> Marvanová & Bär. (1998)	CA	P	Foam	Marvanová and Bärlocher 1998 (illust.)	
<i>Flagellospora curvula</i> Ingold (1942)	GP	F		Ingold 1960	

Species Diversity in the Atlantic Maritime Ecozone

Table 1 (continued).

Species	Location ^a	Method	Source	Reference
	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Bärlocher 1992c
	AC	F		Bärlocher 1987
		S	Leaves	Sridhar and Bärlocher 2000
		S	Moss	Sridhar et al. 2000
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CS	P		Miersch et al. 1997
	CA	W		Bärlocher 2000
	LKN	P	Foam	L.M. 1987, unpubl.
	MB	P	Foam	L.M. 1994, unpubl.
<i>F. saccata</i> Marvanová & Bär. (1989)	SG	P	Foam	Marvanová and Bärlocher 1989 (illustr.)
	AC	P	Foam	Marvanová and Bärlocher 1989
	BC	P	Foam	L.M. 1994, unpubl.
<i>Fontanospora eccentrica</i> (R.H. Petersen) Dyko (1978)	SG	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Bärlocher 1992c
	AC	F		Bärlocher 1987
		P	Foam	L.M. 1994, unpubl.
	DitRP	P	Foam	L.M. 1987, unpubl.
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	GA	P	Foam	L.M. 1994, unpubl.
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
<i>F. fusiramosa</i> Marvanová et al. (1997)	DitRP	P	Foam	Marvanová et al. 1997 (illustr.)
	AC	S	Leaves	Sridhar and Bärlocher 1993 (as <i>F. breviramosa</i> [sic])
		S	Leaves	Sridhar and Bärlocher 1993 (as <i>F. breviramosa</i>)
<i>Geniculospora grandis</i> Greath. ex Nolan (1972)	BB	S	Leaves	Sridhar and Bärlocher 1993
<i>G. inflata</i> (Ingold) Marvanová & Sv. Nilsson (1971)	HgwR	P	Foam	L.M. 1987, unpubl.
	LKN	P	Foam	L.M. 1987, unpubl.
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
<i>Goniopila monticola</i> (Dyko) Marvanová & Descals (1985)	SG	P	Foam	L.M. 1994, unpubl.
	BB	P	Foam	L.M. 1994, unpubl.
	SDCh	P	Foam	L.M. 1994, unpubl.
	CA	P	Foam	L.M. 1994, unpubl.
<i>Gyoerffyella rotula</i> (Höhn.) Marvanová (1967)	LChR	P	Foam	L.M. 1994, unpubl.
<i>G. speciosa</i> (K. Miura) Dudka (1974)	SC	F		Bärlocher 1987
	CA	W		Bärlocher 2000
<i>Heliscella stellata</i> (Ingold & V.J. Cox) Marvanová & Sv. Nilsson (1980)	SG	F		Bärlocher 1987
		P	Foam	L.M. 1987, unpubl.
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
	AC	F		Bärlocher 1987
	TMB	F		Bärlocher 1987

Table 1 (continued).

Species	Location ^a	Method	Source	Reference
<i>Heliscina campanulata</i> Marvanová (1980)	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	Sckw	P	Foam	
	CA	W		Bärlocher 2000
	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	BB	F		Bärlocher 1987
	AC	F		Bärlocher 1987
<i>Heliscus lugdunensis</i> Sacc. & Théry (1880)		P	Foam	L.M. 1987, unpubl.
	TMB	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	ChR	P	Foam	L.M. 1994, unpubl.
	CA	W		Bärlocher 2000
	GP	F		Ingold 1960
	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Tree roots	Sridhar and Bärlocher 1992a
		S	Tree roots	Sridhar and Bärlocher 1992b
		P	Tree roots	Sridhar and Bärlocher 1992b
		S	Leaves	Bärlocher 1992c
		S	Leaves	Sridhar and Bärlocher 1993
	AC	F		Bärlocher 1987
	P	Foam	L.M. 1987, unpubl.	
	S	Leaves	Sridhar and Bärlocher 2000	
	S	Moss	Sridhar et al. 2000	
TMB	F		Bärlocher 1987	
SC	F		Bärlocher 1987	
WB	F		Bärlocher 1987	
TC	F		Bärlocher 1987	
CCB	F		Bärlocher 1987	
CA	W		Bärlocher 2000	
<i>Isthmotricladia britannica</i> Descals (1982)		S	Leaves+	Garnett et al. 2000
		P	Foam	L.M. 1987, unpubl.
	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Sridhar and Bärlocher 1993
	AC	F		Bärlocher 1987
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
WB	F		Bärlocher 1987	
HgwL	P	Foam	L.M. 1987, unpubl.	
CA	W		Bärlocher 2000	
<i>Jaculispora submersa</i> H.J. Huds. & Ingold (1960)	AC	F		Bärlocher 1987
<i>Lambdasporium viridense</i> Nawawi (1985)	CA	W		Bärlocher 2000
<i>Lateriramulosa minitriangularia</i> Matsush. (1975)		S	Leaves	Garnett et al. 2000
	BB	S	Leaves	Sridhar and Bärlocher 1993
		P	Foam	Marvanová and Bärlocher 2001
<i>L. quadriradiata</i> K. Miura & Okano (1979)	DChR	P	Foam	Marvanová and Bärlocher 2001 (illustr.)
		F		Bärlocher 1987
<i>L. uni-inflata</i> Matsush. (1971)	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	S	Leaves	Sridhar and Bärlocher 1993

Species Diversity in the Atlantic Maritime Ecozone

Table 1 (continued).

Species	Location ^a	Method	Source	Reference	
<i>Lemmoniera aquatica</i> De Wild. (1894)	TMB	F		Bärlocher 1987	
	TC	F		Bärlocher 1987	
	JB	P	Foam	L.M. 1994, unpubl.	
	MB	P	Foam	L.M. 1994, unpubl.	
	CA	W		Bärlocher 2000	
		P	Foam	L.M. 1994, unpubl.	
	GP	F		Ingold 1960	
	SG	F		Bärlocher 1987	
	LKL	F		Bärlocher 1987	
	LKR	F		Bärlocher 1987	
	BB	F		Bärlocher 1987	
		S	Leaves	Bärlocher 1992c	
		S	Leaves	Sridhar and Bärlocher 1993c	
	AC	F		Bärlocher 1987	
		S	Leaves	Sridhar and Bärlocher 2000	
		S	Moss	Sridhar et al. 2000	
	TMB	F		Bärlocher 1987	
	SC	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
TC	F		Bärlocher 1987		
CCB	F		Bärlocher 1987		
SL	P	Foam	L.M. 1987, unpubl.		
CA	W		Bärlocher 2000		
<i>L. centrosphaera</i> Marvanová (1968)		S	Leaves+	Garnett et al. 2000	
	LKL	F		Bärlocher 1987	
	AC	S	Leaves	Sridhar and Bärlocher 2000	
		S	Moss	Sridhar et al. 2000	
	CA	W		Bärlocher 2000	
	CA	S	Leaves	Garnett et al. 2000	
		P	Foam	L.M. 1994, unpubl.	
	CB	P	Foam	L.M. 1994, unpubl.	
	ChR	P	Foam	L.M. 1994, unpubl.	
	<i>L. filiformis</i> R.H. Peterson ex Dyko (1977)	LKL	F		Bärlocher 1987
AC		F		Bärlocher 1987	
SC		F		Bärlocher 1987	
CA		W		Bärlocher 2000	
<i>L. pseudofloscula</i> Dyko (1977)		SG	P	Foam	L.M. 1987, unpubl.
	BB	P	Foam	L.M. 1994, unpubl.	
	CA	P	Foam	L.M. 1994, unpubl.	
	GA	P	Foam	L.M. 1994, unpubl.	
<i>L. terrestris</i> Tubaki (1958)	GP	F		Ingold 1960	
	SG	F		Bärlocher 1987	
	LKL	F		Bärlocher 1987	
	LKR	F		Bärlocher 1987	
	LKN	P	Foam	L.M. 1987, unpubl.	
	BB	F		Bärlocher 1987	
	AC	F		Bärlocher 1987	
	TMB	F		Bärlocher 1987	
	SC	F		Bärlocher 1987	
	WB	F		Bärlocher 1987	
	TC	F		Bärlocher 1987	
	CCB	F		Bärlocher 1987	
	DitRP	P	Foam	L.M. 1987, unpubl.	
	CA	W		Bärlocher 2000	
		S	Leaves	Garnett et al. 2000	
		P	Foam	L.M. 1994, unpubl.	
	GA	P	Foam	L.M. 1994, unpubl.	
	<i>Lunulospora curvula</i> Ingold (1942)	BB	F		Bärlocher 1987
		AC	F		Bärlocher 1987

Table 1 (continued).

Species	Location ^a	Method	Source	Reference
	TMB	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
<i>L. cymbiformis</i> K. Miura (1972)	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
<i>Margaritispora aquatica</i> Ingold (1942)	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
		P	Foam	L.M. 1987, unpubl.
	BB	F		Bärlocher 1987
		S	Leaves	Bärlocher 1992c
	AC	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	Sckw	P	Foam	L.M. 1987, unpubl.
<i>Miniancora allisoniensis</i> Marvanová & Bär. (1989)	Hgw	P	Foam	Marvanová and Bärlocher 1989 (illust.)
	CA	W		Bärlocher 2000
<i>Mycocentrospora acerina</i> (R. Hartig) Deighton (1972)	LKR	F		Bärlocher 1987
	AC	F		Bärlocher 1987
		S	Leaves	Sridhar and Bärlocher 2000
		S	Moss	Sridhar et al. 2000
	BB	S	Leaves	Bärlocher 1992c
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
<i>M. aquatica</i> (S.H. Iqbal) S.H. Iqbal (1974)	SG	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Sridhar and Bärlocher 1993
<i>Mycofalcella calcarata</i> Marvanová, Om-Kalth. & J. Webster (1993)	BB	P	Foam	L.M. 1994, unpubl.
<i>Naiadella fluitans</i> Marvanová & Bandoni (1987)	BB	S	Leaves	Sridhar and Bärlocher 1993
<i>Nodulospora inconstans</i> Marvanová & Bär. (2000)	BB	P	Foam	Marvanová and Bärlocher 2000 (illust.)
	ArsB	P	Foam	Marvanová and Bärlocher 2000
	CB	P	Foam	Marvanová and Bärlocher 2000 (illust.)
	ChRR	P	Foam	Marvanová and Bärlocher 2000
	SDCh	P	Foam	Marvanová and Bärlocher 2000 (illust.)
	GA	P	Foam	Marvanová and Bärlocher 2000 (illust.)
<i>Pachycladina parva</i> Marvanová & Bär. (1998)	LSMR	P	Foam	Marvanová and Bärlocher 1998 (illust.)
<i>Phalangispora constricta</i> Nawawi & J. Webster (1982)	BB	S	Tree roots	Sridhar and Bärlocher 1992a
		S	Leaves	Sridhar and Bärlocher 1993
<i>Pleuropedium macrum</i> Marvanová & Bär. (1998)	CA	P	Foam	Marvanová and Bärlocher 1998 (illust.)
<i>P. multiseptatum</i> Marvanová & Descals (1996)	ChR	P	Foam	L.M. 1994, unpubl.
<i>P. tricladioides</i> Marvanová & S.H. Iqbal (1973)	AC	F		Bärlocher 1987
		P	Foam	L.M. 1994, unpubl.
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
<i>Pseudoanguillospora stricta</i> S.H. Iqbal (1974)	HgwR	P	Foam	L.M. 1994, unpubl.
	ChR	P	Foam	L.M. 1994, unpubl.
<i>Sigmoidea prolifera</i> (R.H. Petersen) J.L. Crane (1968)	CA	W		Bärlocher 2000
<i>Spirosphaera dimorpha</i> Marvanová & Bär. (1998)	SG	P	Foam	Marvanová and Bärlocher 1998

Species Diversity in the Atlantic Maritime Ecozone

Table 1 (continued).

Species	Location ^a	Method	Source	Reference
	AC	P	Foam	Marvanová and Bärlocher 1998 (illustr.)
	AR	P	Foam	Marvanová and Bärlocher 1998
	DitRP	P	Foam	Marvanová and Bärlocher 1998
<i>Stenocladia neglecta</i> (Marvanová & Descals) Marvanová & Descals (1987)	CA	W		Bärlocher 2000 (as <i>Leptocladia</i> [sic] <i>neglecta</i> Marvanová & Descals (1985))
	ArsB	P	Foam	L.M. 1994, unpubl.
<i>Symptodiadium frondosum</i> Descals (1982)	SR	P	Foam	Marvanová and Bärlocher 2001 (illustr.)
	MB	P	Foam	Marvanová and Bärlocher 2001 (illustr.)
<i>Taeniospora descalsii</i> Marvanová & Stalpers (1987)	CA	W		Bärlocher 2000
	ChR	P	Foam	L.M. 1994, unpubl.
<i>T. gracilis</i> Marvanová (1977)	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Bärlocher 1992c
		S	Leaves	Sridhar and Bärlocher 1993
	AC	F		Bärlocher 1987
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
<i>T. gracilis</i> var. <i>enecta</i> Marvanová & Stalpers (1987)	AC	P	Leaves	Marvanová and Bärlocher 1988 (illustr.)
	BB	P	Foam	L.M. 1994, unpubl.
<i>T. gracilis</i> Marvanová var. <i>gracilis</i> (1977)	SG	P	Foam	Marvanová and Bärlocher 1988 (illustr.)
<i>T. nasifera</i> Marvanová & Bärlocher (1988)	SG	F		Marvanová and Bärlocher 1988 (illustr.)
	CA	F		Bärlocher 2000
<i>Tetrabrachium elegans</i> Nawawi & Kuthub. (1987)	BB	S	Tree root	Sridhar and Bärlocher 1992b
		P	Tree root	Sridhar and Bärlocher 1992b
		S	Leaves	Sridhar and Bärlocher 1993
<i>Tetrabruneospora ellisii</i> Dyko (1978)	ChRR	P	Foam	Marvanová and Bärlocher 2001 (illustr.)
<i>Tetrachaetium elegans</i> Ingold (1942)	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Bärlocher 1992b
	AC	F		Bärlocher 1987
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
	WF	P	Foam	L.M. 1994, unpubl.
	OMB	P	Foam	L.M. 1994, unpubl.
<i>Tetracladium apiense</i> R.C. Sinclair & Eicker (1981)	CA	W		Bärlocher 2000
<i>T. furcatum</i> Descals (1983)	AC	P	Foam	L.M. 1987, unpubl.
	CA	W		Bärlocher 2000
<i>T. marchalianum</i> De Wild. (1893)	GP	F		Ingold 1960
	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	S	Leaves	Sridhar and Bärlocher 1993
	AC	S	Moss	Sridhar et al. 2000
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987

Table 1 (continued).

Species	Location ^a	Method	Source	Reference
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	HgwR	P	Foam	L.M. 1987, unpubl.
	CS	P		Miersch et al. 1997
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
<i>T. maxilliforme</i> (Rostr.) Ingold (1942)	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	AC	F		Bärlocher 1987
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
<i>T. setigerum</i> (Grove) Ingold (1942)	SG	F		Bärlocher 2000
	LKL	F		Bärlocher 2000
	LKR	F		Bärlocher 2000
	BB	F		Bärlocher 2000
		S	Tree roots	Sridhar and Bärlocher 1992a
		S	Leaves	Sridhar and Bärlocher 1993
		S	Leaves	Sridhar and Bärlocher 2000
	AC	F		Bärlocher 1987
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	Sckw	P	Foam	L.M. 1987, unpubl.
	HgwR	P	Foam	L.M. 1987, unpubl.
	CA	W		Bärlocher 2000
<i>Tricellula aquatica</i> J. Webster (1959)	CA	W		Bärlocher 2000
<i>T. aurantiaca</i> (Haskins) Arx (1970)	SL	P	Foam	L.M. 1987, unpubl.
<i>Tricladium angulatum</i> Ingold (1942)	GP	F		Ingold 1960
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
		S	Leaves	Garnett et al. 2000
<i>T. anomalum</i> Ingold (1944)	CA	S	Leaves	Garnett et al. 2000
<i>T. attenuatum</i> S.H. Iqbal (1971)	AC	F		Bärlocher 1987
	CA	W		Bärlocher 2000
		P	Foam	L.M. 1994, unpubl.
	Chr	P	Foam	L.M. 1994, unpubl.
	GA	P	Foam	L.M. 1994, unpubl.
<i>T. biappendiculatum</i> (G.R.W. Arnold) Marvanová & Descals (1987)	LKL	F		Bärlocher 1987 (as <i>Gyoerffyella biappendiculata</i>)
	AC	P	Foam	L.M. 1987, unpubl.
	TMB	F		Bärlocher 1987 (as <i>Gyoerffyella biappendiculata</i> (G.R.W. Arnold) Ingold (1974))
	DitRP	P	Foam	L.M. 1987, unpubl.
	BB	S	Leaves	Sridhar and Bärlocher 1993
	AR	P	Foam	L.M. 1994, unpubl.
	GA	P	Foam	L.M. 1994, unpubl.
	CA	W		Bärlocher 2000
<i>T. caudatum</i> Kuzuha (1973)	LKR	P	Foam	Marvanová and Bärlocher 2001
	OB	P	Foam	Marvanová and Bärlocher 2001 (illust.)
<i>T. chaetocladium</i> Ingold (1974)	SG	F		Bärlocher 1987

Species Diversity in the Atlantic Maritime Ecozone

Table 1 (continued).

Species	Location ^a	Method	Source	Reference
	LKR	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
		S	Leaves	Garnett et al. 2000
<i>T. curvisporum</i> Descals (1983)	LKN	P	Foam	L.M. 1987, unpubl.
<i>T. minutum</i> (S.H. Iqbal) Marvanová & Descals (1996)	SG	F		Bärlocher 1987 (as <i>Scorpiosporium minutum</i> S.H. Iqbal (1974))
	AC	F		Bärlocher 1987 (as <i>S. minutum</i>)
	WB	F		Bärlocher 1987 (as <i>S. minutum</i>)
	TC	F		Bärlocher 1987 (as <i>S. minutum</i>)
	Hgw	P	Foam	L.M. 1987, unpubl.
	CA	W		Bärlocher 2000 (as <i>S. minutum</i>)
	Hgw	P	Foam	L.M. 1994, unpubl.
	MB	P	Foam	L.M. 1994, unpubl.
<i>T. patulum</i> Marvanová (1963)	BB	F		Bärlocher 1987
	LKR	P	Foam	L.M. 1987, unpubl.
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
<i>T. splendens</i> Ingold (1942)	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	S	Leaves	Sridhar and Bärlocher 1993
	AC	S	Moss	Sridhar et al. 2000
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	Sckw	P	Foam	L.M. 1987, unpubl.
	CA	W		Bärlocher 2000
<i>T. terrestre</i> D. Park (1974)	CA	S	Leaves	Garnett et al. 2000
<i>Trifurcospora irregularis</i> (Matsush.) K. Ando & Tubaki. (1988)	CA	P	Foam	Marvanová and Bärlocher 2001 (illust.)
<i>Triglyphium alabamense</i> Matsush. (1981)	OMB	P	Foam	Marvanová and Bärlocher 2001 (illust.)
<i>Triposperrum camelopardus</i> Ingold, Dann & P.J. McDougall (1968)	LKL	F		Bärlocher 1987
	BB	S	Leaves	Sridhar and Bärlocher 1993
	TMB	F		Bärlocher 1987
	TC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
		S	Leaves	Garnett et al. 2000
<i>T. myrti</i> (Lind) S. Hughes (1951)	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	L	Leaves	Sridhar and Bärlocher 1993
	AC	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
		S	Leaves	Garnett et al. 2000
<i>Triscelophorus acuminatus</i> Nawawi (1975)	BB	S	Leaves	Sridhar and Bärlocher 1993
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
<i>T. magnificus</i> R.H. Petersen (1962)	SG	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Leaves	Sridhar and Bärlocher 1993
	TMB	F		Bärlocher 1987
	CA	S	Leaves	Garnett et al. 2000
<i>T. monosporus</i> Ingold (1944)	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987

Table 1 (continued).

Species	Location ^a	Method	Source	Reference
	LKR	F		Bärlocher 1987
	AC	F		Bärlocher 1987
	TMB	F		Bärlocher 1987
	CA	W		Bärlocher 2000
	CA	S	Leaves	Garnett et al. 2000
<i>Trisulcosporium acerinum</i> H.J. Huds. & B. Sutton (1964)	CA	W		Bärlocher 2000
<i>Tumularia aquatica</i> (Ingold) Descals & Marvanová (1987)	LKL	F		Bärlocher 1987 (as <i>Pyricularia aquatica</i> Ingold (1943))
	LKR	F		Bärlocher 1987 (as <i>P. aquatica</i>)
	BB	S	Leaves	Bärlocher 1992d (as <i>P. aquatica</i>)
		P		Miersch et al. 1997
	TMB	F		Bärlocher 1987 (as <i>P. aquatica</i>)
	SC	F		Bärlocher 1987 (as <i>P. aquatica</i>)
	WB	F		Bärlocher 1987 (as <i>P. aquatica</i>)
	TC	F		Bärlocher 1987 (as <i>P. aquatica</i>)
	CCB	F		Bärlocher 1987 (as <i>P. aquatica</i>)
	CA	W		Bärlocher 2000
<i>T. tuberculata</i> (J. Gönczöl) Descals & Marvanová (1987)	SG	F		Bärlocher 1987 (as <i>Monotosporella tuberculata</i> J. Gönczöl (1976))
	AC	F		Bärlocher 1987 (as <i>M. tuberculata</i>)
	SC	F		Bärlocher 1987 (as <i>M. tuberculata</i>)
<i>Varicosporium delicatum</i> S.H. Iqbal (1971)	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	BB	F		Bärlocher 1987
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	Hgw	P	Foam	L.M. 1987, unpubl.
	HgwL	P	Foam	L.M. 1987, unpubl.
	SL	P	Foam	L.M. 1987, unpubl.
	BIB	P	Foam	L.M. 1994, unpubl.
	CA	P	Foam	L.M. 1994, unpubl.
	ChR	P	Foam	L.M. 1994, unpubl.
	LChR	P	Foam	L.M. 1994, unpubl.
	LSMR	P	Foam	L.M. 1994, unpubl.
	SR	P	Foam	L.M. 1994, unpubl.
<i>V. elodeae</i> W. Kegel (1906)	SG	F		Bärlocher 1987
	LKL	F		Bärlocher 1987
	LKR	F		Bärlocher 1987
	BB	F		Bärlocher 1987
		S	Tree roots	Sridhar and Bärlocher 1992a
		S	Tree roots	Sridhar and Bärlocher 1992b
		P	Tree roots	Sridhar and Bärlocher 1992b
		S	Leaves	Sridhar and Bärlocher 1993
	AC	F		Bärlocher 1987
		P	Foam	L.M. 1987, unpubl.
		S	Leaves	Sridhar and Bärlocher 2000
		S	Foam	Sridhar et al. 2000
	TMB	F		Bärlocher 1987
	SC	F		Bärlocher 1987
	WB	F		Bärlocher 1987
	CCB	F		Bärlocher 1987
	DitRP	P	Foam	L.M. 1987, unpubl.
	Hgw	P	Foam	L.M. 1987, unpubl.
	CA	W		Bärlocher 2000
		S	Leaves+	Garnett et al. 2000
<i>V. giganteum</i> J.L. Crane (1968)	AC	F		Bärlocher 1987

Table 1 (concluded).

Species	Location ^a	Method	Source	Reference
		P	Foam	L.M. 1987, 1994, unpubl.
		S	Leaves	Sridhar and Bärlocher 2000
		S	Moss	Sridhar et al. 2000
	BB	S	Tree roots	Sridhar and Bärlocher 1992a
		S	Tree roots	Sridhar and Bärlocher 1992a
		P	Tree roots	Sridhar and Bärlocher 1992a
		S	Leaves	Sridhar and Bärlocher 1992a
	CA	W		Bärlocher 2000
	SL	P	Foam	L.M. 1987, unpubl.
	ChLB	P	Foam	L.M. 1987, unpubl.
	SR	P	Foam	L.M. 1987, unpubl.
<i>V. trimosum</i> Wolfe (1976)	BIB	P	Foam	Marvanová and Bärlocher 2001
	MB	P	Foam	Marvanová and Bärlocher 2001 (illust.)
<i>Variocladium giganteum</i> (S.H. Iqbal) Descals & Marvanová (1999)	AC	F		Bärlocher 1987 (as <i>Tricladium giganteum</i> S.H. Iqbal (1971))
<i>Ypsilina graminea</i> (Ingold, P.J. McDougall & Dann) J. Webster, Descals & Marvanová (1999)	LKL	F		Bärlocher 1987 (as <i>Volucrispora graminea</i> Ingold, P.J. McDougall & Dann (1968))
	LKR	F		Bärlocher 1987 (as <i>V. graminea</i>)
	LKR	P	Foam	Marvanová and Bärlocher 2001 (illust.)
	BB	S	Leaves	Sridhar and Bärlocher 1993 (as <i>V. graminea</i>)
	AC	F		Bärlocher 1987 (as <i>V. graminea</i>)
	TMB	F		Bärlocher 1987 (as <i>V. graminea</i>)
	SC	F		Bärlocher 1987 (as <i>V. graminea</i>)
	CCB	F		Bärlocher 1987 (as <i>V. graminea</i>)
	Hgw	P	Foam	L.M. 1987, unpubl.
	Sckw	P	Foam	L.M. 1987, unpubl.
	NAR	P	Foam	L.M. 1994, unpubl.
	CA	W		Bärlocher 2000 (as <i>V. graminea</i>)

^aAC, Allen Creek (Wood Point, N.B.); AR, Apple River (Chignecto Game Sanctuary, N.S.); ArsB, Arsenic Brook (Cobequid Mountains, N.S.); BB, Boss Brook (Fenwick, N.S.); BC, Breau Creek (Dorchester, N.B.); BIB, Black Brook (Cobequid Mts., N.S.); CA, Catamaran Brook (Miramichi Region, N.B.); CCB, Cedar Camp Brook (Waterford, N.B.); CB, Corney Brook (Cape Breton National Park, N.S.); ChLB, Chain Lake Brook (Cobequid Mts., N.S.); ChR, Cheticamp River (Cape Breton National Park, N.S.); ChRR, right tributary of ChR (Cape Breton National Park, N.S.); CS, Copper Mine (Sackville, N.B.); DChR, ditch near the Cheticamp River (Cape Breton National Park, N.S.); DitRP, roadside ditch near Allen Creek (Rock Point, N.B.); FB, Farm Brook (Cape Breton National Park, N.S.); GA, Grande Anse (Cape Breton National Park, N.S.); GP, 3 streams in Gaspé Peninsula (Que.); Hgw, small stream near the Trans Canada Highway (Sackville, N.B.); HgwL, left tributary of the Ogden Mill Brook near the Trans Canada Highway (Sackville, N.B.); HgwR, right tributary of a roadside stream along the Trans Canada Highway (Sackville, N.B.); JB, Jeffer's Brook (Colchester County, N.S.); LChR, Left arm of Cheticamp River (Cape Breton National Park, N.S.); LKL, Lime Kiln Brook, left branch (Fenwick, N.S.); LKN, Lime Kiln Brook North Branch (Fenwick, N.S.); LKR, Lime Kiln Brook right branch (Fenwick, N.S.); LR, Little River (Bathurst, N.B.); LSMR, Little Southwest Miramichi (Miramichi Region, N.B.); MB, Murphy Brook (Cobequid Mts., N.S.); NAR, North Aspy River (Cape Breton National Park, N.S.); OB, Otter Brook (Miramichi Region, N.B.); OMB, Ogden Mill Brook (Sackville, N.B.); PB, Poyd Brook (Colchester County, N.S.); RPWB, River Philip West Branch (Cobequid Mts., N.S.); RW, Rockwell Creek (Cobequid Mts., N.S.); SC, Stony Creek (Memramcook, N.B.); SDCh, side ditch of Cheticamp River (Cape Breton National Park, N.S.); SG, St. George's Brook (Fenwick, N.S.); SL, unnamed stream at Silver Lake near Silver Shores (Sackville, N.B.); SR, Shulie River (Chignecto Game Sanctuary, N.S.); SREB, Southampton River, East Branch (Cobequid Mts., N.S.); TC, Trout Creek (Waterford, N.B.); TMB, Three Mile Brook (Sackville, N.B.); WB, Weissner Brook (Moncton, N.B.); WF, Ward's Falls (Colchester County, N.S.).

Table 2. Some taxa that are difficult to identify or easily confused with others when only detached conidia are available.

- Alatospora constricta* vs. *Articulospora tetracladia* (if smaller and thinner than normal)
- Alatospora pulchella* vs. *Sympodiocladium frondosum* or small-spored *Articulospora tetracladia*
- Anguillospora crassa* vs. *Anguillospora furtiva* (if aged, swollen)
- Anguillospora filiformis* vs. *Calcarispora hiemalis*
- Anguillospora furtiva* vs. *Anguillospora rosea* or *Anguillospora longissima*
- Articulospora atra* vs. *Articulospora tetracladia* (if small)
- Crucella subtilis* vs. *Nodulospora inconstans* (if relatively simple)
- Cryptococcus aquaticus* vs. various *Candida* spp.
- Cylindrocarpon aquaticum* vs. *Cylindrocarpon destructans*

Table 2 (concluded).

Cylindrotrichum helisciforme vs. *Heliscina campanulata*
Dactylella microaquatica — detached conidia are not diagnostic enough
Dendrospora erecta vs. *Dendrospora tenella*
Dendrospora fastuosa vs. *Dendrospora fusca* (if less branched than usual)
Dimorphospora foliicola vs. unidentified heterobasidiomycetous anamorph
Fibulotaeniella canadensis vs. *Flagellospora saccata*
Fontanospora eccentrica vs. *Fontanospora fusiramosa* (if large)
Geniculospora grandis vs. *Articulospora tetracladia* (if large with broad arms)
Geniculospora inflata vs. *Lemonniera aquatica*
Goniopila monticola vs. *Margaritispora aquatica*
Heliscina campanulata vs. *Heliscus lugdunensis* (if conidia < 20 µm)
Jaculispora submersa vs. *Naiadella fluitans*
Lambdasporium viridense vs. *Alatospora acuminata* (if single-branched)
Lateriramulosa minitriangularia vs. of *Lateriramulosa uni-inflata* (if small)
Lemonniera centrosphaera vs. *Lemonniera alabamensis*
Lemonniera pseudofloscula vs. *Tetrabrachium elegans*
Lemonniera terrestris vs. *Lemonniera cornuta*
Mycocentrospor acerina vs. *Mycofalcella calcarata*
Mycocentrospora aquatica is a doubtful taxon
Mycocentrospora clavata vs. *Colispora elongata*
Phalangispora constricta vs. *Trisulcosporium acerinum*
Pleuropedium multiseptatum vs. *Pleuropedium tricladioides*
Sigmoidea prolifera vs. *Flagellospora saccata* vs. *Fibulotaeniella canadensis*
Spirosphaera dimorpha vs. *Spirosphaera minuta*
Tricladium angulatum vs. *Tricladium minutum*
Tricladium anomalum — doubtful taxon
Triscelophorus magnificus — doubtful taxon
Varicosporium trimosum vs. partial conidia of *Varicosporium elodeae*

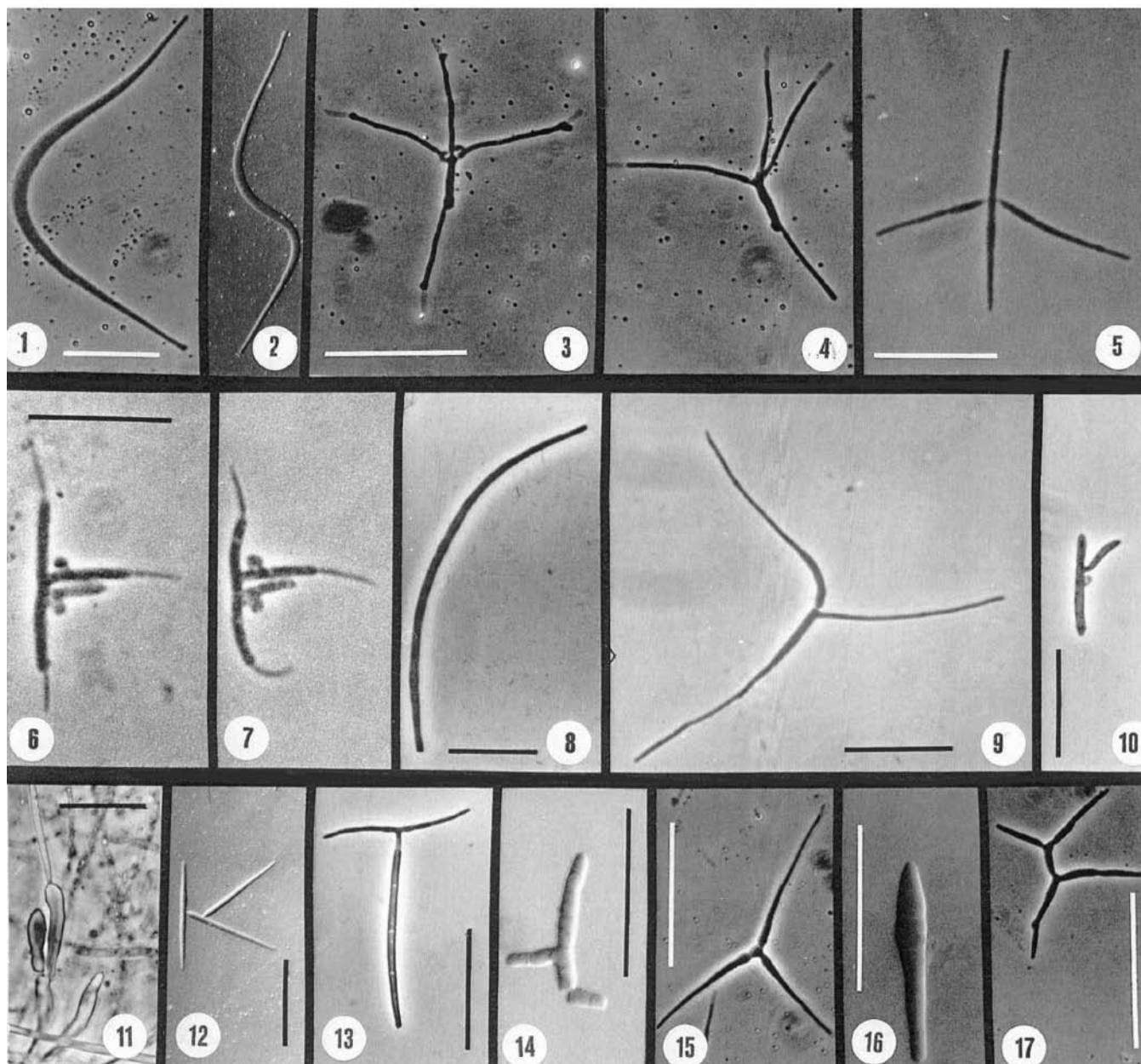
Table 3. Glossary of some mycological terms.

Anamorph	Asexual (mitosporic) state of ascomycetes or basidiomycetes
Ascomycetes	Fungi producing asci in the sexual state, usually in a fruit-body
Ascus	Meiosporangium, often a sac-like cell, produces (usually 8) ascospores inside
Basidiomycetes	Fungi producing basidia in the sexual state, usually in a fruit-body
Basidium	Meiosporangium, often club-shaped, produces (usually 4) basidiospores outside on short outgrowths called sterigmata
Basipetal	Sequence of conidia where the youngest conidium is at the base and the oldest at the apex of a chain
Caudal branch	A branch at the base of conidium
Chlamydospore	Asexual, often thick-walled resting spore, usually formed by differentiation of hyphal cell
Clamp connection	A hyphal bridge or bypass over a septum between two dikaryotic cells
Conidial primordium	The first stage of a developing conidium
Conidiogenesis	The process of conidium formation
Conidiogenous cell	A cell producing conidia
Conidiophore	A specialized fertile hypha bearing conidiogenous cells
Conidium	Asexual spore in ascomycetes and basidiomycetes produced by a conidiogenous cell; plural: conidia
Constricted branch insertion	The base of a branch abruptly narrows
Dematiaceous	With dark cell walls
Hypha	A filament of the mycelium
Hyphomycetes	Anamorphic fungi, producing conidia on conidiophores scattered singly on hyphae or aggregated into fascicles
Hyphopodia	Short lateral outgrowths on hyphae
Microconidia	Small conidia; in ascomycetes often used for spermatia, i.e., nongerminating conidia presumed to ensure fertilization
Micronematous conidiophore	Indistinct, morphologically similar to vegetative hyphae
Mycelium	Thallus of a fungus, mass of hyphae
Partial conidium	A fragment of a complexly branched conidium
Percurrent proliferation	New growth of a conidiogenous cell through its apex
Phialide	A usually flask-shaped conidiogenous cell, often with a collarette at the apex, producing conidia in basipetal chains or in slimy heads from its open end

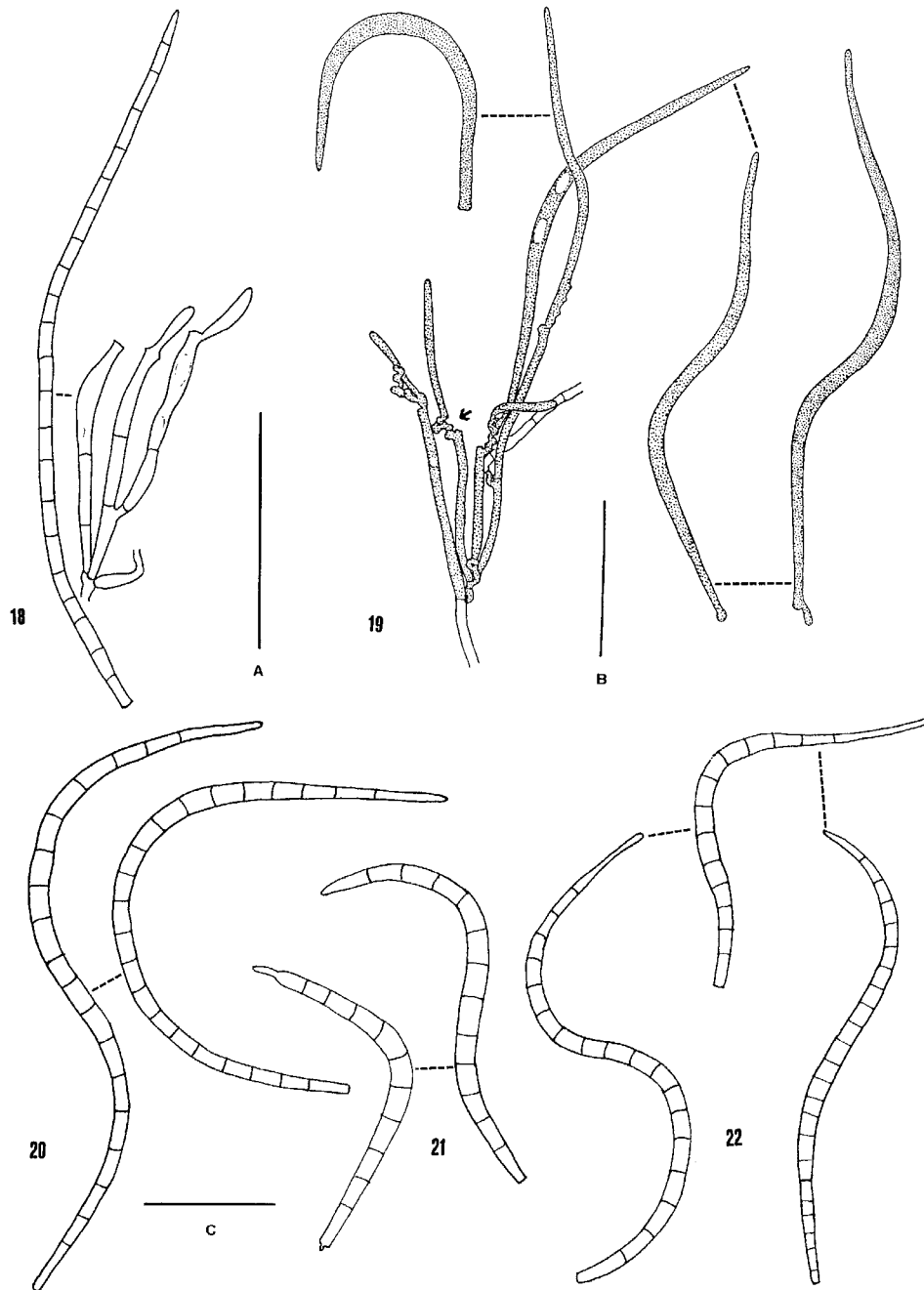
Table 3 (concluded).

Phialoconidium	A conidium produced by a phialide
Proliferating conidiogenous cell	Conidiogenous cell that successively develops new parts on its apex
Spermatia	See microconidia
Sympodial proliferation	New growth of a conidiogenous cell below the previously formed conidium
Teleomorph	Sexual state of ascomycetes or basidiomycetes
Tetrradiate conidium	Conidium with four arms diverging from common point
Triradiate conidium	Conidium with three arms diverging from common point

Figs. 1–17. Photomicrographs of conidia of streamborne fungi, reported as new or rare taxa from streams in the Maritime Provinces New Brunswick and Nova Scotia. 1, 2, *Anguillomyces acadensis*. Scale bar = 50 µm. 3, 4, *Nodulospora inconstans*. Scale bar = 50 µm. 5, *Arborispora paupera*. Scale bar = 25 µm. 6, 7, *Arcispora bisagittaria*. Scale bar = 20 µm. 8, *Fibulotaeniella canadensis*. Scale bar = 20 µm. 9, *Lambdasporium* state of *Spirosphaera dimorpha*. Scale bar = 20 µm. 10, *Taeniospora nasifera*. Scale bar = 20 µm. 11, *Flagellospora saccata*, inflated phialides and one developing conidium. Scale bar = 25 µm. 12, *Pleuropedium macrum*. Scale bar = 50 µm. 13, *Miniancora allisoniensis*. Scale bar = 20 µm. 14, *Pachycladina parva*. Scale bar = 50 µm. 15, *Trifurcospora irregularis*. Scale bar = 50 µm. 16, *Filosporella pinguis*. Scale bar = 50 µm. 17, *Tricladium caudatum*. Scale bar = 50 µm.

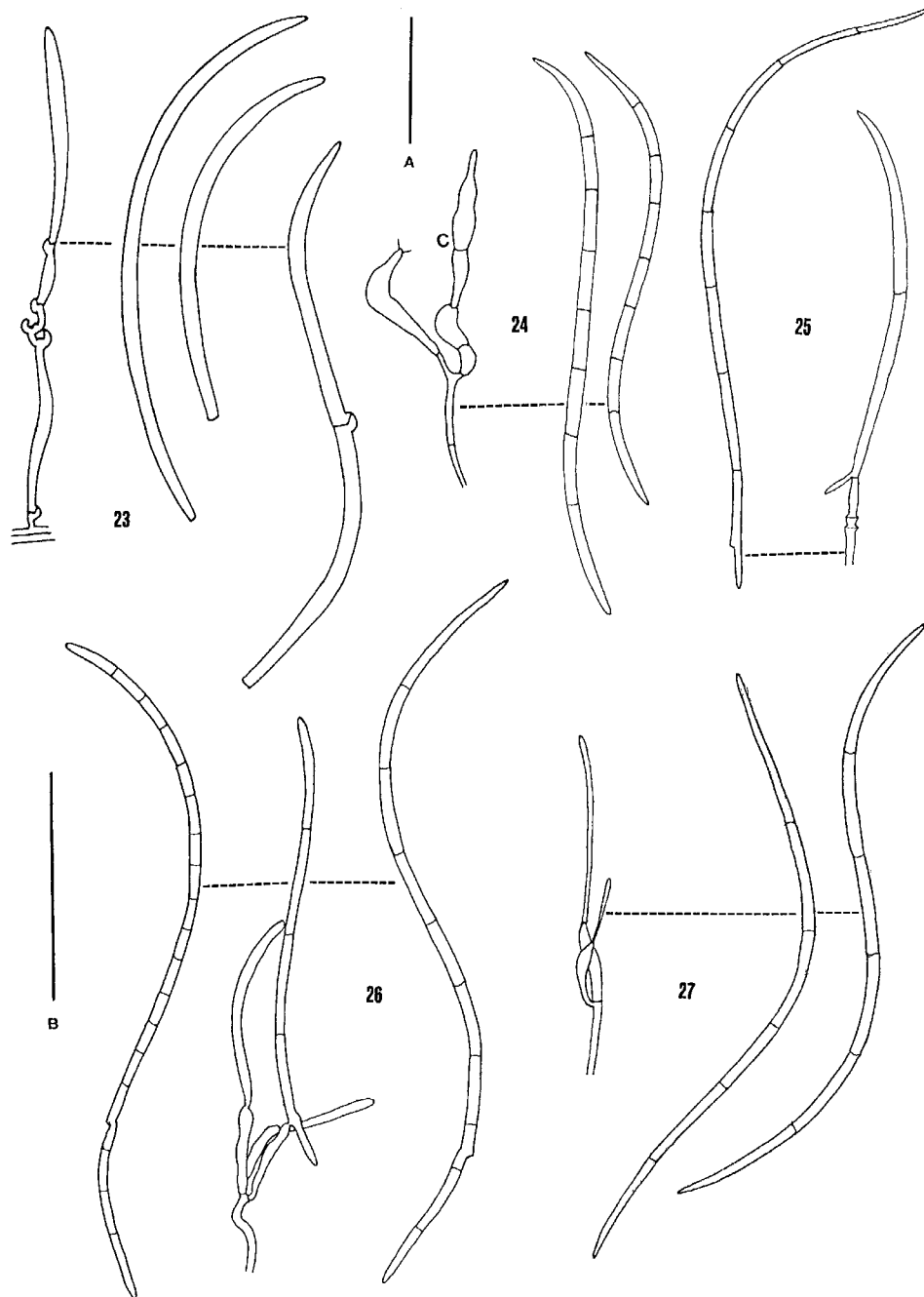


Figs. 18–22. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 18, *Pseudoanguillospora stricta*, detached conidium and conidiophore with proliferating conidiogenous cells. 19, *Anguillomyces acadensis* (conidial basidiomycete), three detached conidia and conidiophore with developing conidia. Note remnants of clamp connections on the conidiogenous cells. Undotted structures are devoid of protoplasm. 20, *Anguillospora rosea*, two detached conidia. 21, *Anguillospora crassa*, two detached conidia. 22, *Anguillospora furtiva*, three detached conidia. Note the similarity of conidia of *A. rosea*, *A. crassa*, and *A. furtiva*. Scale bars A (Fig. 18), B (Fig. 19), C (Figs. 20–22) = 50 μm .

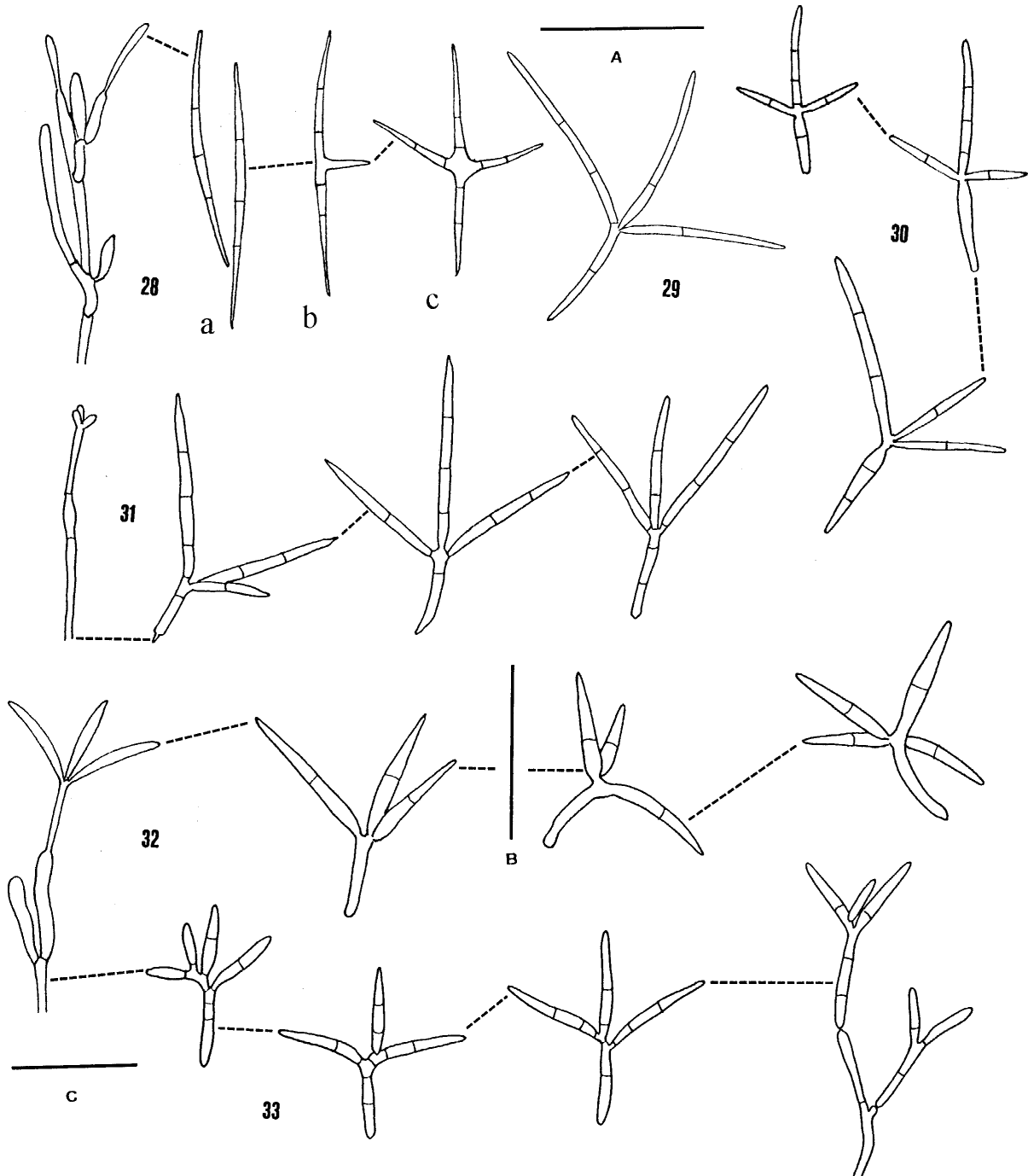


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Figs. 23–27. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 23, *Fibulotaeniella canadensis* (conidial basidiomycete), conidiophore with developing conidium, detached conidia. 24, *Flagellospora saccata*, conidiophore with two inflated phialides (one proliferated), and two detached conidia. 25, *Anguillospora filiformis*, detached conidium and conidiophore with developing conidium. Note the caudal conidial branch developing in situ. 26, *Calcarispora hiemalis*, conidiophore with developing conidia and two conidia released. Note the similarity of conidia of *A. filiformis* and *C. hiemalis*. The two species differ in conidiogenesis: in *A. filiformis* the conidiogenous cells proliferate percurrently and conidial insertion is broad, whereas in *C. hiemalis*, conidiogenous cells are nonproliferating phialides and conidia are strongly constricted at the site of insertion. 27, *Flagellospora curvula*, conidiophore with two conidia developing and two conidia detached. Scale bars A (Figs. 23, 24) = 20 μm , B (Figs. 25–27) = 50 μm .

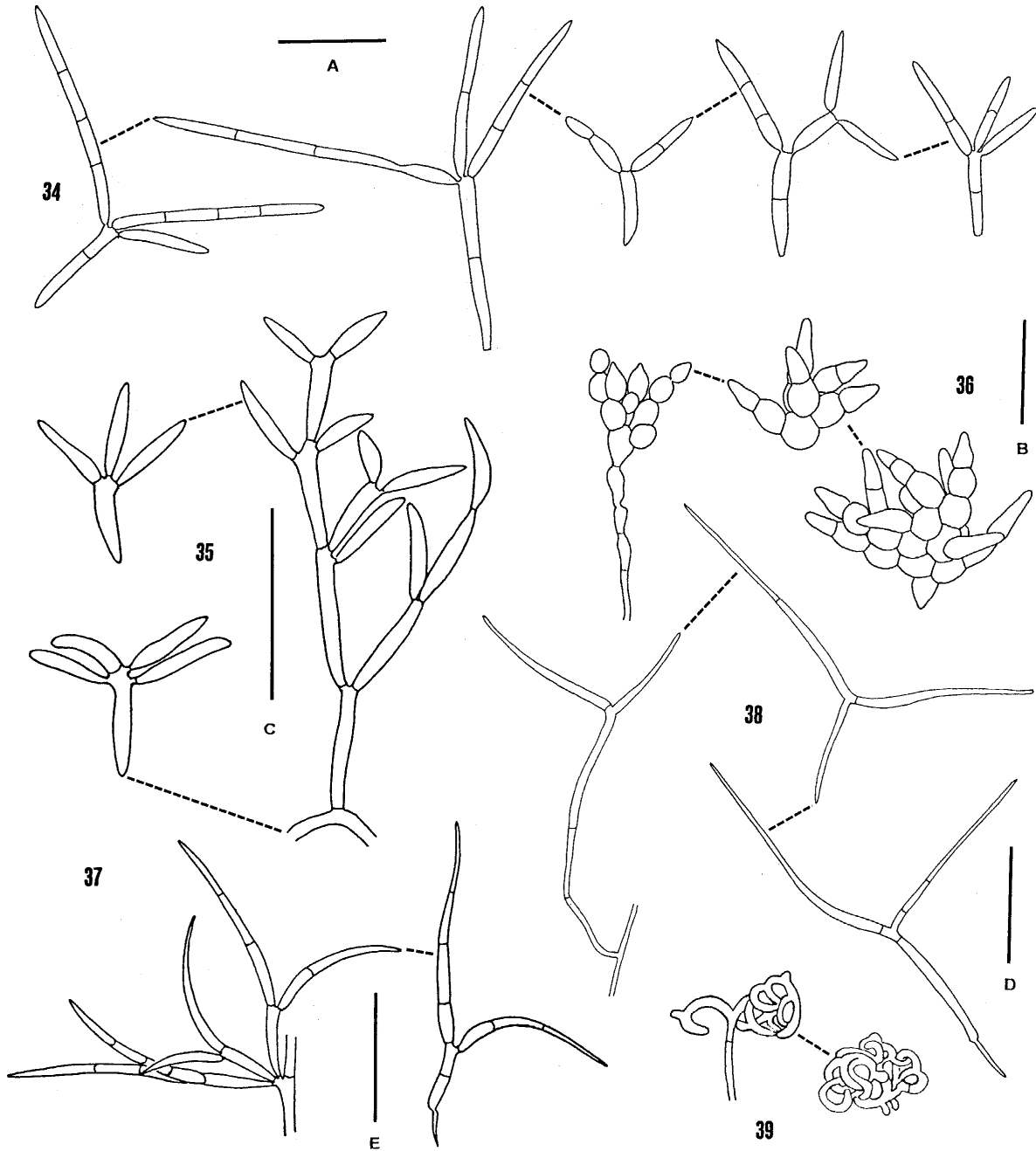


Figs. 28–33. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 28, *Alatospora acuminata* s. str. Conidiophore with developing conidia; (a) unbranched conidia; (b) triradiate conidium; (c) tetradiradiate conidium. Proportion of these three kinds of conidia varies with strains. 29, *Alatospora acuminata* s.l., detached conidium. Note the constricted conidial branch insertion here in contrast to lack of constriction in *A. acuminata* s. str. 30, *Stenoclaadiella neglecta*, detached conidia. 31, *Alatospora constricta*, conidial primordium and three conidia detached. Note the similarity of conidia to those of *Stenoclaadiella neglecta*. 32, *Alatospora pulchella*, conidiophore with a conidium developing and three detached. 33, *Sympodiocladium frondosum*, detached conidia and conidiophore with two conidia developing. Scale bars A (Fig. 29), B (Figs. 28, 30, 32), C (Figs. 31, 33) = 25 µm.

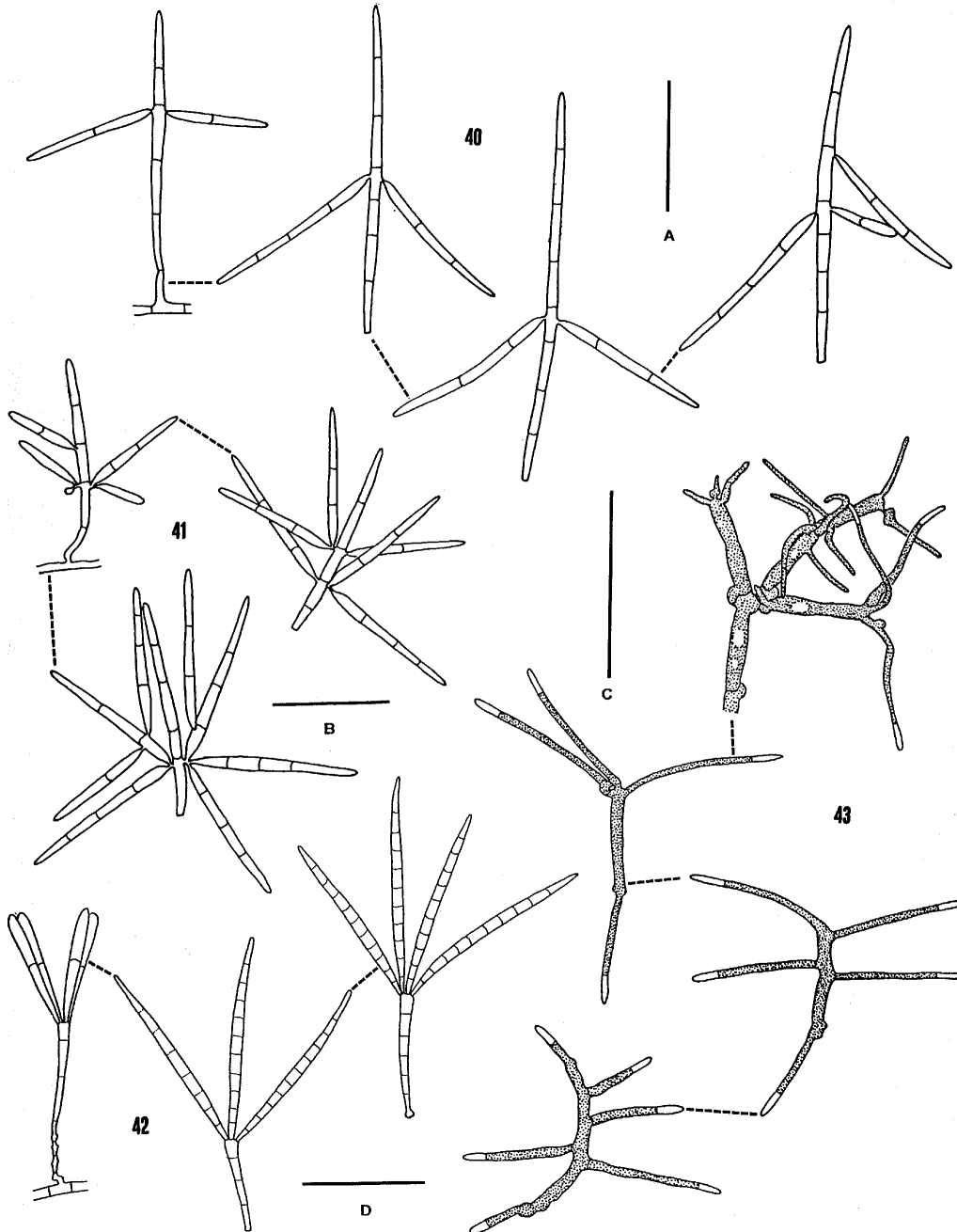


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Figs. 34–39. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 34, Detached conidia of *Articulospora tetracladia*. Note the great variation in size and shape. 35, *Articulospora atra*, two detached conidia and conidia developing on branched conidiophore. Conidia may be confused with the smaller ones of *A. tetracladia*. 36, *Arbusculina irregularis*. Conidiophore with developing conidium and two detached conidia of various complexity. 37, *Ypsilina graminea*. Conidia developing on a fertile hypha and a detached conidium. 38, *Lambdasporium* state of *Spirosphaera dimorpha*, conidium developing on simple conidiophore and two detached conidia. 39, *Spirosphaera* state of *Spirosphaera dimorpha*, developing terminal conidium (left) and detached conidium. Scale bars A (Fig. 34), B (Fig. 36), C (Fig. 35), D (Figs. 38, 39), E (Fig. 37) = 20 μ m.

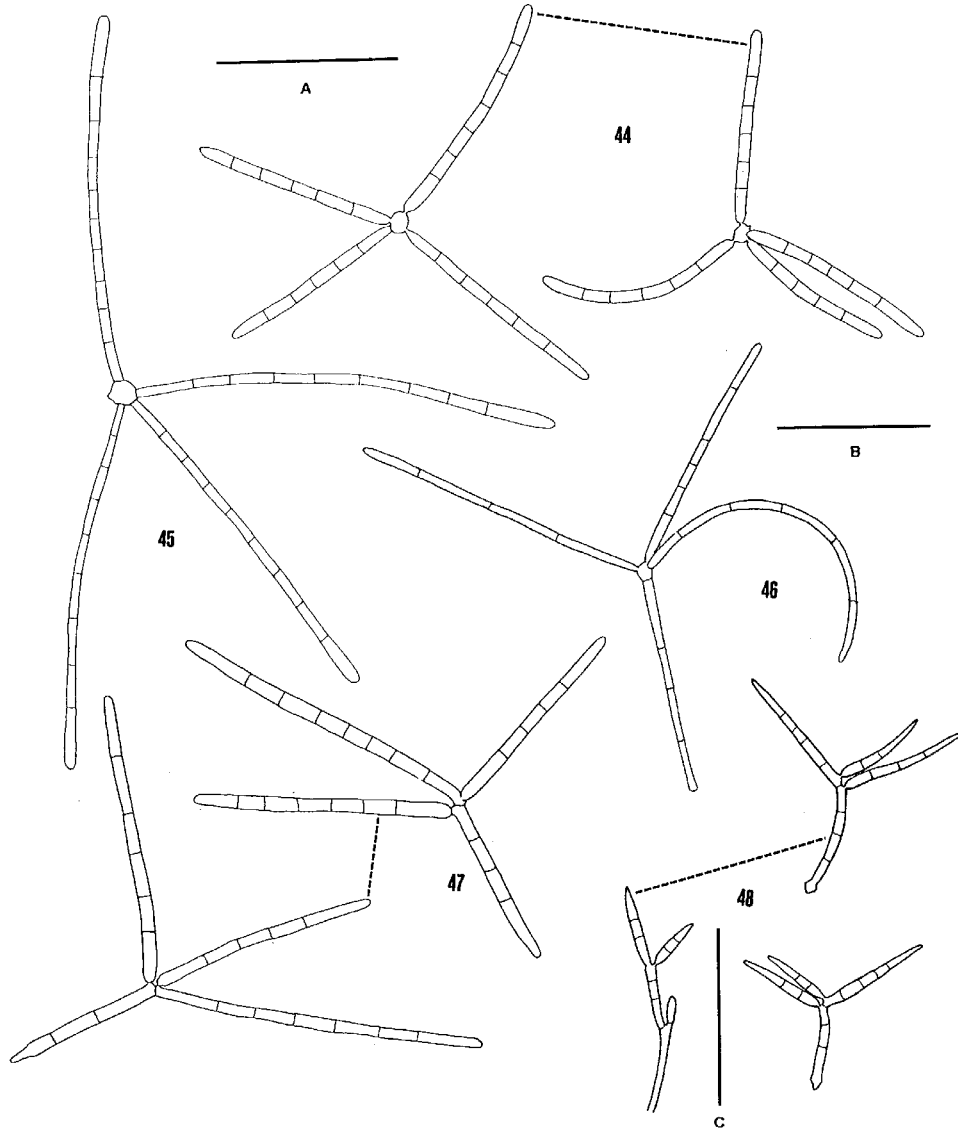


Figs. 40–43. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 40, *Arborispora paupera*, conidium on micronematous conidiophore and three detached conidia. 41, *Arborispora dolichovirga*, conidium on micronematous conidiophore and two detached conidia. 42, *Isthmotricladia britannica*, conidium on micronematous conidiophore and two liberated conidia. 43, *Nodulospora inconstans* (conidial basidiomycete), developing conidia (*top*) and three detached ones (undotted conidial tips are devoid of protoplasm). Note the varying number and location of conidial branches. Scale bars A (Fig. 40) = 20 μm , B (Fig. 41) = 25 μm , C (Fig. 43) = 50 μm , D (Fig. 42) = 25 μm .

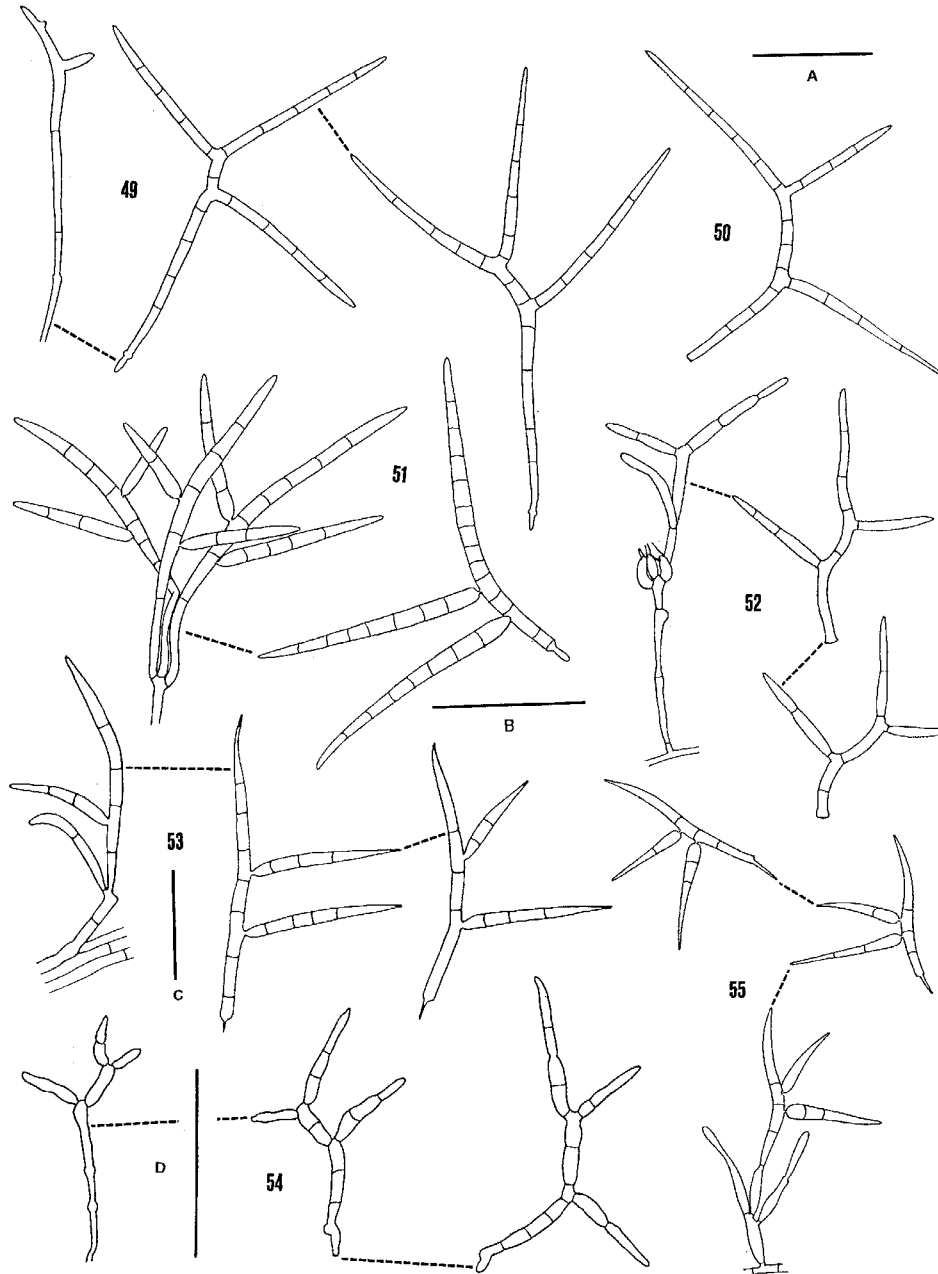


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Figs. 44–48. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 44, Two detached conidia of *Lemonniera pseudofloscula*. Note the constricted conidial branch bases. 45, Detached conidium of *Lemonniera centrosphaera*, with unconstricted conidial branch bases and slightly widened branch tips. 46, *Geniculospora inflata*, detached conidium. 47, Two detached conidia of *Fontanospora eccentrica*. 48, *Fontanospora fusiramosa*, developing conidium on conidiophore (left) and two detached conidia. Scale bars A (Figs. 44, 45, 47), B (Fig. 46), C (Fig. 48) = 50 μ m.

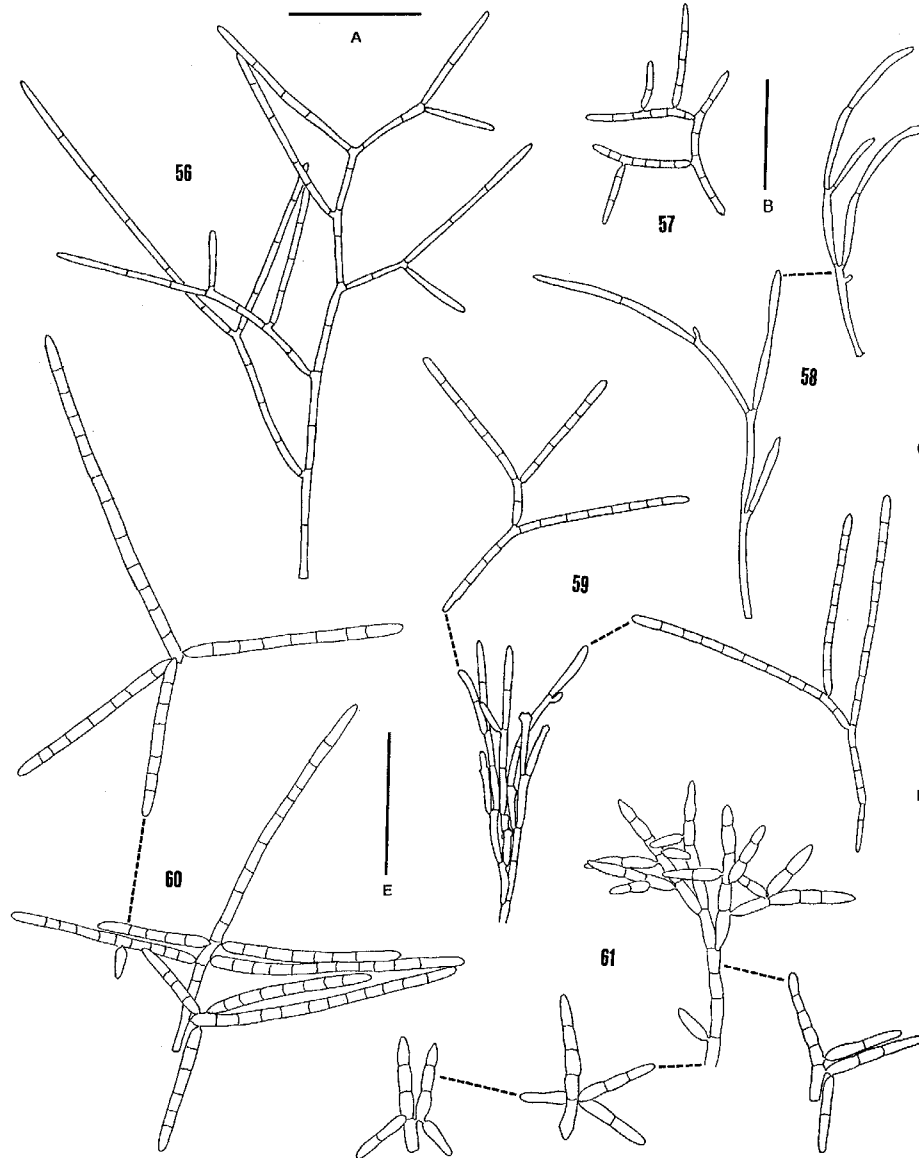


Figs. 49–55. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 49, *Tricladium minutum*, developing terminal conidium (*left*) and two detached conidia. 50, Detached conidium of *Tricladium angulatum*. Note the similarity with conidia of *T. minutum*. 51, *Tricladium splendens*, developing conidia and liberated conidium. 52, *Tricladium curvisporum*, developing conidium with a microconidial state on the same conidiophore (*left*) and two detached conidia. 53, *Tricladium attenuatum* (drawing not based on Canadian isolate). Developing conidia on conidiophore (*left*) and two detached conidia. Note the characteristic sharp conidial tips. 54, *Tricladium caudatum*, developing conidium and two detached conidia. 55, *Tricladium biappendiculatum*. Conidial development (*bottom*) and two detached conidia. Scale bars A (Figs. 49, 50, 52, 55), C (Fig. 53) = 25 μm , B (Fig. 51), D (Fig. 54) = 50 μm .

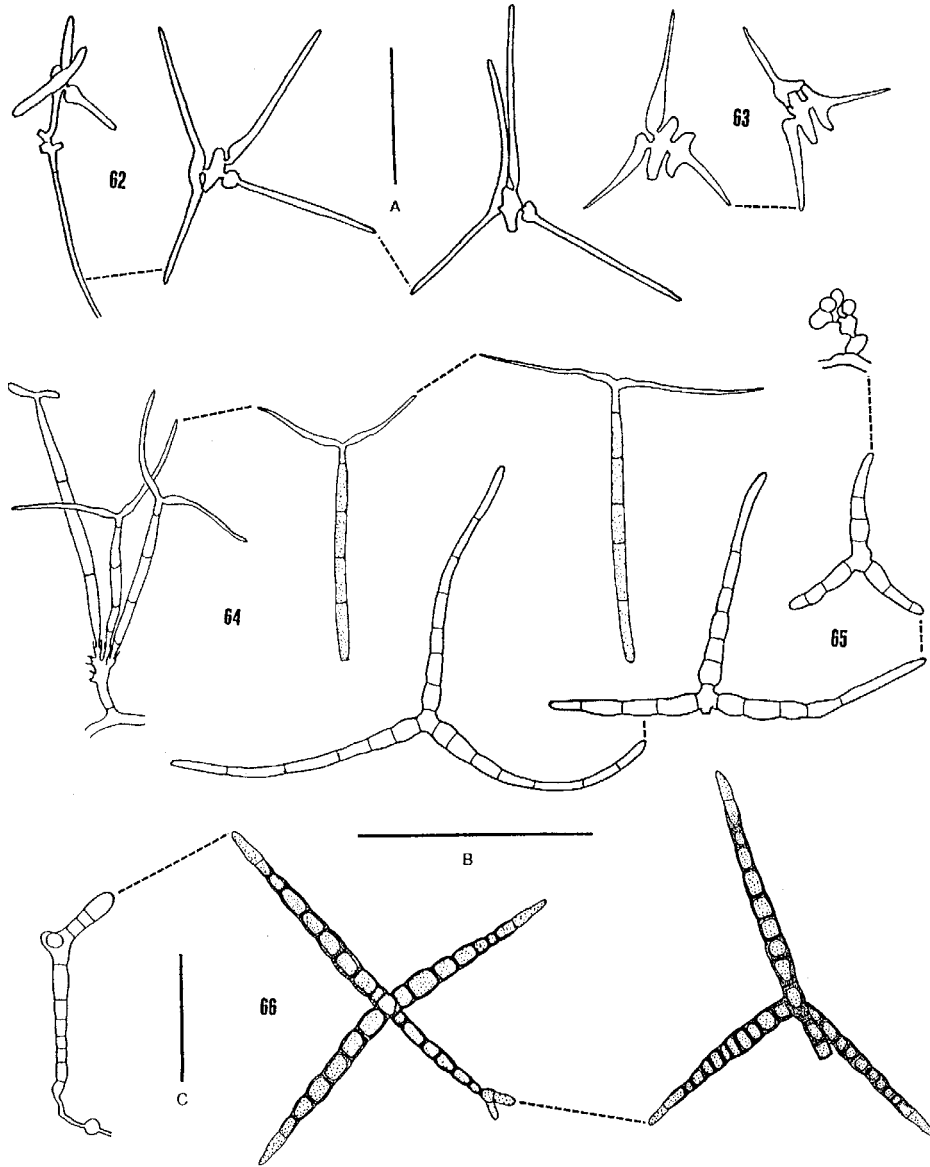


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Figs. 56–61. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 56, *Varicosporium giganteum*, detached conidium. 57, *Varicosporium elodeae*, detached conidium. 58, *Varicosporium delicatum*, two detached conidia. 59, *Varicosporium trimosum*, conidiophore with developing conidia and two detached conidia. 60, *Dendrospora tenella*, a complex conidium (bottom) and a more simple partial conidium (above). 61, *Dendrospora nana*, branched conidiophore with developing conidia (above) and three detached conidia. Scale bars A (Fig. 56), B (Fig. 57), D (Fig. 59), E (Fig. 60) = 50 μm , C (Figs. 58, 61) = 25 μm .

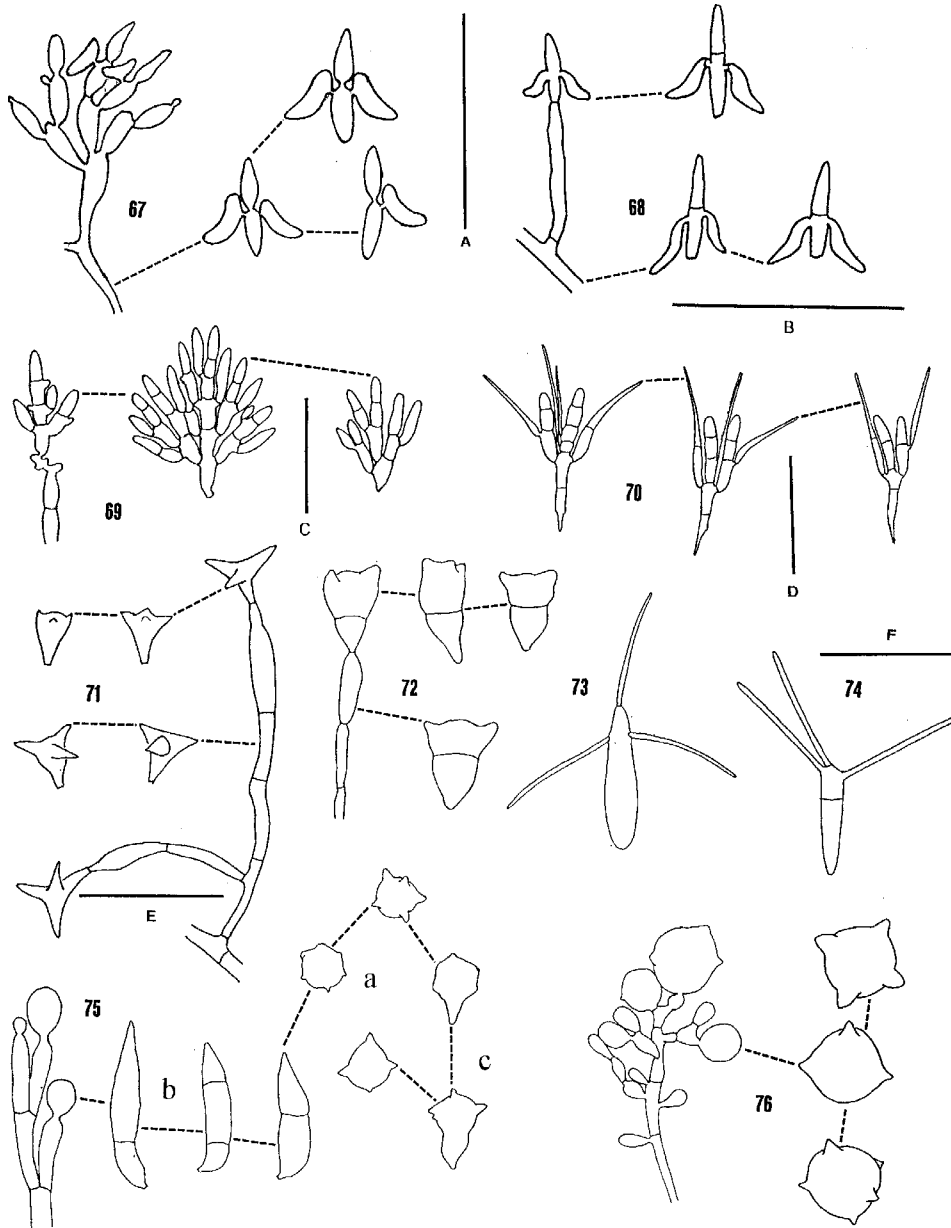


Figs. 62–66. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 62, *Lateriramulosa quadriradiata*, conidiophore apex with developing conidium and two detached conidia (right). 63, *Lateriramulosa uni-inflata*, two detached conidia. 64, *Miniancora allisoniensis*, three young conidia on micronematous conidiophore and two detached conidia (undotted parts of detached conidia are devoid of protoplasm). 65, *Trifurcospora irregularis*, developing conidium on micronematous conidiophore (above) and three detached conidia. Note the great variation in size. 66, *Tetrabrunneospora ellisii*, conidial primordium on micronematous conidiophore (left) and two detached conidia. This species is dematiaceous and the detached conidia are brown, whereas the conidiogenous structure is pale brown. Scale bars A (Figs. 62–64) = 20 μm , B (Fig. 65), C (Fig. 66) = 50 μm .

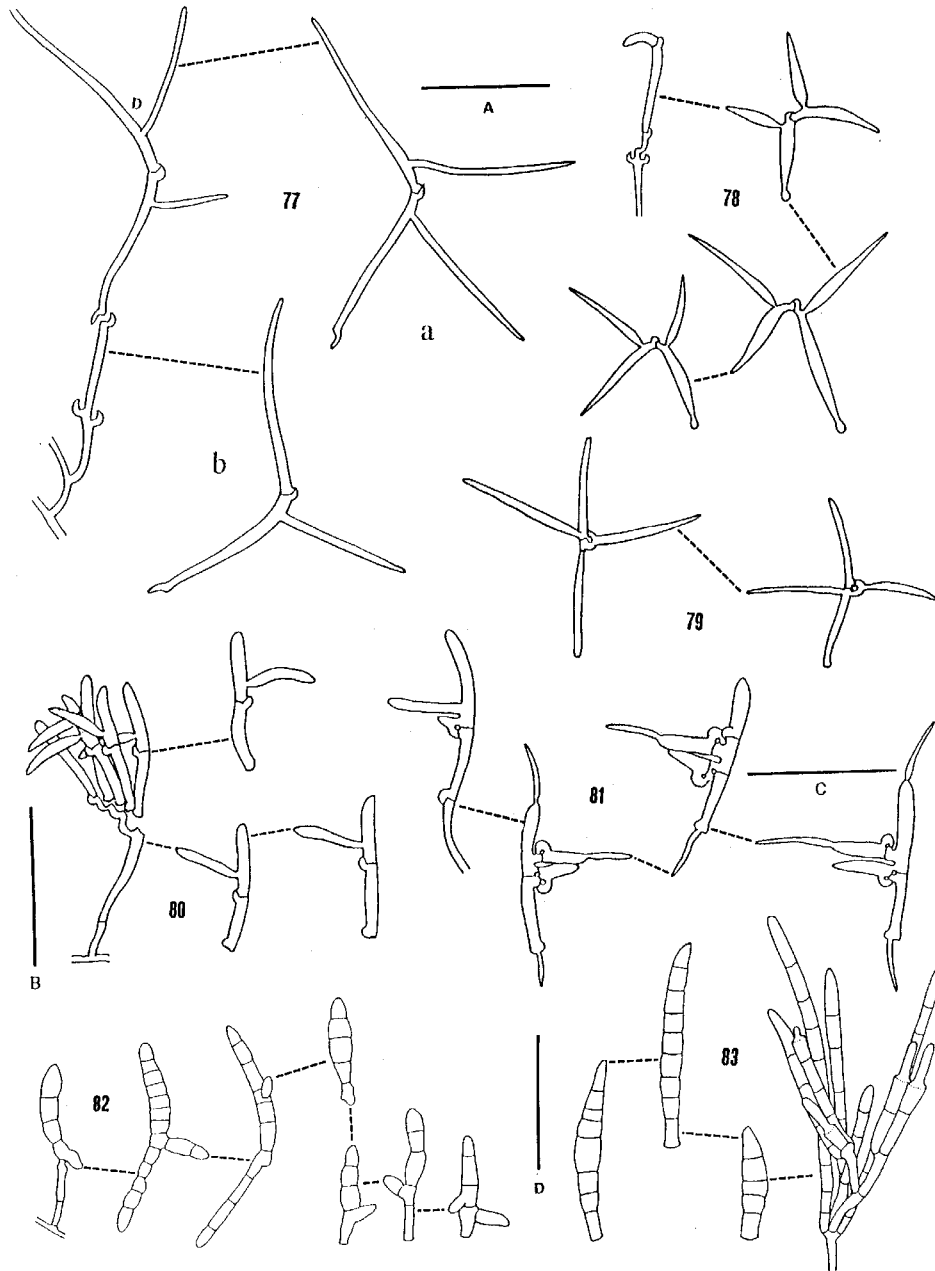


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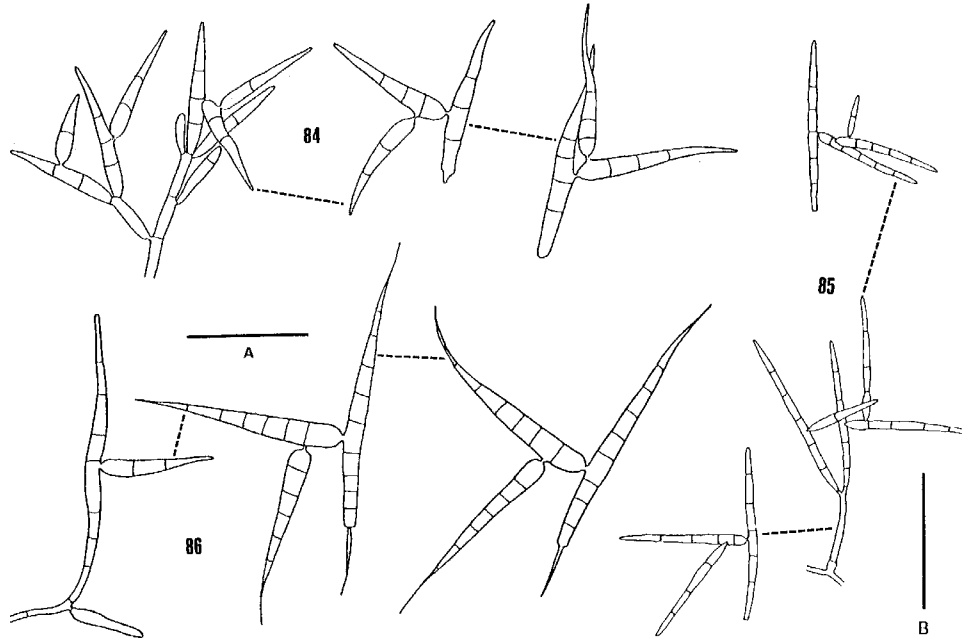
Figs. 67–76. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 67, *Tricellula aurantiaca*, cluster of conidia developing on conidiophore apex (left) and three detached conidia. 68, *Triglyphium alabamense*, single terminal conidium developing on conidiophore (left) and three detached conidia. Note the similarity of conidia with those of *T. aurantiaca*. 69, *Cladoconidium articulatum*, developing conidium (left) and two detached conidia. 70, Three detached conidia of *Tetracladium furcatum*. 71, *Heliscella stellata*. Two developing conidia on a branched conidiophore (right) and four variously shaped detached conidia. 72, *Heliscina campanulata*. Developing conidium (left) and three detached conidia. 73, *Naiadella fluitans* (conidial basidiomycete). Detached conidium (undotted parts are devoid of protoplasm). 74, *Clavatospora longibrachiata*, detached conidium. 75, *Margaritispora aquatica* (drawing of conidiophore not based on Canadian isolate), conidiophore with conidial primordia (left); (a) isodiametric conidia obtained in aerated water culture; (b) elongate conidia seen in culture submerged in standing water; (c) conidia intermediate between a and b, developing in standing submerged culture. 76, *Goniopila monticola*, developing conidia on conidiophore (left) and three detached conidia. Note the similarity (except of size) of *Margaritispora* and *Goniopila* detached conidia. Scale bars A (Fig. 67), B (Fig. 68), C (Figs. 69, 73), D (Figs. 70, 72, 75, 76) = 25 μ m, E (Fig. 71), F (Fig. 74) = 20 μ m.



Figs. 77–83. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 77, *Taeniospora gracilis* var. *enecta* (conidial basidiomycete; developing conidium on conidiophore; (a) typical conidium; (b) single-branched conidium, appearing often in field samples of foam). 78, *Taeniospora gracilis* var. *gracilis* (conidial basidiomycete), young stage of conidium on conidiophore (left) and three detached conidia. 79, Two detached conidia of *Taeniospora descalsii* (conidial basidiomycete). 80, *Taeniospora nasifera* (conidial basidiomycete), a series of conidia just developed on a conidiophore apex (left) and three detached conidia. 81, *Arcispora bisagittaria* (conidial basidiomycete), developing conidium (left) and three detached conidia. 82, *Pachycladina parva*, conidium on conidiophore apex and six detached conidia with varying number of branches. 83, *Filosorella pinguis*, three detached conidia and developing conidia on branched conidiophore. Scale bars A (Figs. 77–79), B (Fig. 80) = 20 μ m, C (Fig. 81) = 25 μ m, D (Figs. 62, 83) = 50 μ m.



Figs. 84–86. Drawings of conidia, mostly with conidiogenous structures, of streamborne fungi isolated from streams in New Brunswick and Nova Scotia by L.M. 84, *Pleuropedium tricladioides*, conidia developing in groups on conidiophore branches (left) and two detached conidia. 85, *Pleuropedium macrum*, two conidia developing on conidiophore (middle) and two conidia detached. 86, *Pleuropedium multi-septatum*, conidium developing singly on conidiophore apex (left) and two detached conidia. Note the sharply pointed conidial apices and different conidiogenesis in *P. tricladioides* vs. *P. multiseptatum*. Scale bars A (Figs. 84, 86) = 25 μm , B (Fig. 85) = 50 μm .



some taxa that may easily be confused with others when identification is based on detached conidia. Photographs of conidia considered to be rare or reported as new from New Brunswick and Nova Scotia are shown in Figs. 1–17. Drawings of conidia and conidiogenous structures of additional species isolated from streams in the same regions by L.M. are given in Figs. 18–86. A glossary of mycological terms is provided in Table 3.

Major factors affecting species diversity in the ecozone

If we wish to establish the influence of a factor on an independent variable, we must compare the variance among groups (with or without exposure to the factor) to the variance within groups (Bärlocher 1999). In the case of aquatic hyphomycetes, or any other biological community, this implies a thorough knowledge of the natural variability of the community before we can establish the effects of human intervention with any certainty. Unfortunately, the vast majority of studies on aquatic fungi have been restricted to one or two yearly cycles. How likely is it that patterns found in such surveys are validated by longer term studies? In a 5-year study at two sites of Catamaran Brook, New Brunswick, monthly water samples were filtered and trapped conidia were counted and identified (Bärlocher 2000). There was a clear, reproducible peak in the number of conidia in the five October samples (a few weeks after leaf

fall). Total species numbers in the five 12-month periods were also reasonably constant; site 1: 46–56, site 2: 41–47. However, only 30 and 26, respectively, of the species occurred in all 5 years. No significant difference was found among the ranks of the top 7 (site 1) or top 10 (site 2) species. Finally, significant correlations between abundances of individual species during 1 or 2 year periods were rarely validated in subsequent periods. Overall, the study revealed considerable yearly fluctuations in the specific composition of the fungal community, while total species number and conidium production remained reasonably constant. Obviously, this limits our ability to identify natural or human-induced factors that significantly influence the occurrence and ecological roles of aquatic hyphomycetes.

Temperature

Aquatic hyphomycetes are widely distributed, occurring from the arctic circle to the equator (Bärlocher 1992a). They were first described from temperate regions, and much of the taxonomic work has continued to concentrate on these areas. Reports of their occurrence in the tropics (based on observations of conidia) date back to the 1950s, and the first pure cultures were isolated in the 1960s (for review, see Marvanová 1997). Many new taxa were described in the 1980s and 1990s by A. Nawawi and A. Kuthubutheen; in a survey of aquatic hyphomycetes Sridhar et al. (1992) list 78 species, 32 of which are believed to have their sole or main distribution in waters of the tropics or subtropics. In earlier reviews (Nilsson 1964;

Webster and Descals 1981; Wood-Eggenschwiler and Bärlocher 1985), three distribution types were distinguished:

- (1) Species that are cosmopolitan, but more common in either temperate and cold or tropical regions.
- (2) Species restricted to either temperate and cold or tropical regions.
- (3) Species restricted to a very small area, or their type locality, in either temperate and cold or tropical regions.

Unfortunately, unequivocal placement of any species in Group 2 or 3 is difficult, since very few areas have been sampled for an extended period of time by competent taxonomists. In the few reported studies, optimal temperatures for growth and sporulation are broadly correlated with geographical distribution. In species from temperate regions, growth generally peaks between 15 and 25°C, while sporulation is highest at somewhat lower temperatures. However, stream temperature generally declines with altitude (Hynes 1970). In mountain streams of tropical or subtropical areas, species more characteristic of temperate regions will therefore occur. Conversely, seasonal increases of water temperature allow the periodic appearance of “tropical” species in temperate streams (Webster et al. 1976; Suberkropp 1984).

If global warming increases stream temperatures in the AME by 1–4°C, what effect would this have on local aquatic hyphomycete communities? In view of our very fragmentary knowledge of their current composition, it seems unlikely that we could unequivocally document changes in overall diversity. In some streams, we might see invasions by “tropical” species due to an extended period of relatively high water temperature. We might further expect a shrinking of the so-called rhithron, a stream region extending from the source to the point where the monthly mean temperature rises to 20°C (Hynes 1970), and therefore fewer opportunities for cold-adapted species.

Substrates

Higher temperatures may indirectly influence aquatic hyphomycetes by changing the composition of the riparian vegetation, which is the primary source for fungal substrates. Several studies have suggested that vegetation may influence the fungal community; though this is often difficult to separate from correlated changes in altitude, temperature, or water chemistry (for example, Gönczöl 1971, Chauvet 1991, Fabre 1996, Gulis 2001). Subtle changes in the composition of riparian vegetation due to global warming are unlikely to have any measurable effect. More severe effects can be expected from the complete removal of trees and shrubs from stream banks, which will drastically lower the supply of conventional fungal substrates (Metvalli and Shearer 1989).

Another fairly common human intervention is the replacement of native forests by monocultures of commercial species. One of the most widely planted species in warm climates (Brazil, California, Iberian Peninsula, India) is the blue gum, *Eucalyptus globulus* Labill. (Sridhar et al. 1992; Bärlocher and Graça 2002). Beginning in 1829, extensive monocultures have been established on the Iberian Peninsula, and now occupy

close to 30% of the forest area of Portugal. This has changed the timing of litter accession (maximum in summer rather than fall) and lowered the diversity of food sources for fungi and invertebrates: ≥98% of the leaves are now provided by *E. globulus*. In a recent survey of eight streams, fungal diversity in eucalypt-bordered streams declined by roughly 25% compared with streams in native forests (Bärlocher and Graça 2002); surprisingly, this had no significant effect on the decomposition rate of native chestnut leaves.

Water chemistry

Based on the evidence available at the time, Wood-Eggenschwiler and Bärlocher (1985) concluded that on a worldwide scale, temperature (directly or indirectly through its influence on riparian vegetation) is the main factor determining distribution patterns of aquatic hyphomycetes. Within smaller areas, the chemistry of stream water was believed to be of primary importance. There have been few additional systematic studies since that review. The most thoroughly studied factor is the pH/alkalinity/Ca²⁺ complex (in natural streams, the three are generally strongly correlated; Hynes 1970). Most field surveys suggest a hump-shaped (unimodal) effect: species richness of aquatic hyphomycetes declines noticeably at pH ≤4.5 and ≥8.0 (Bärlocher 1987; Chamier 1992). Unfortunately, pH and Ca²⁺ levels influence the solubilities of other substances; aluminium and other metals become more soluble in acid streams, while phosphate tends to precipitate in the presence of Ca²⁺ ions. Both effects are believed to inhibit fungal growth.

Low nitrate and phosphate levels limit decompositional activity due to fungi; they have also been associated with low fungal diversity (Suberkropp 1991; Chamier 1992; Sridhar and Bärlocher 2000). Conversely, nitrate levels considerably higher than those found in natural streams inhibit the production of fungal conidia. The effects of high levels of dissolved nitrogen and phosphorus on fungal diversity are unknown. Our current working hypothesis is that total metabolic activity of the fungal community generally increases with nitrogen and phosphate, and will only decline at unrealistically high levels. The diversity of the community, on the other hand, may show a hump-shaped response to inorganic nutrient supply, as has been found with primary producers (Huston 1994).

Fungi are also influenced by dissolved organic compounds occurring naturally in streams. Some, like amino acids or simple carbohydrates, are used as nutrients and may stimulate growth; at higher levels they may delay the breakdown of macromolecules (Bengtsson 1988). Other compounds, e.g., humic acids, are natural organic ligands and may influence the toxicity of heavy metals or uptake kinetics of nutrients (Gjessing 1981). Moderate organic pollution (absence of toxins, no drastic effect on oxygen content of stream water) has no clear-cut effect on the aquatic hyphomycete community (Bärlocher 1992c). A loss of 90% of fungal species in an organically polluted stream in India did not significantly lower leaf processing rates (Raviraja et al. 1998).

It is unlikely that any increase in the level of heavy met-

als will stimulate metabolic activity of the fungal community (Bärlocher 1992c), even though fungal diversity can remain remarkably high in heavily contaminated streams (Krauss et al. 2001; Sridhar et al. 2001). Similarly, nonspecific pesticides, such as PCP (pentachlorophenol), probably always depress ecological functions and diversity of aquatic hyphomycetes once their concentration exceeds a critical threshold (Bärlocher and Premdas 1988).

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