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PRELIMINARY STUDY OF AQUATIC HYPHOMYCETES FROM VENEZUELAN STREAMS

Estudio preliminar de hifomicetes acuáticos en cursos de agua dulce de Venezuela

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RESUMEN

Se reportan 50 especies de hifomicetes acuáticos encontrados en siete cursos de agua, de los cuales seis están ubicados en Parques Nacionales. La comunidad de hifomicetes presentó baja similitud ya que sólo cuatro especies fueron comunes en las diferentes localidades: *Campylospora chaetocladia* Ranzoni, *Clavatospora tentacula* Sv.Nilsson, *Triscelophorus acuminatus* Nawawi y *Triscelophorus monosporus* Ingold. La mayoría de los ríos tienen especies particulares cuyo número oscila entre uno y tres. En el Río Los Castillos las especies fueron: *Anguillospora longissima* (Sacc. & P.Syd) Ingold, *Angulospora aquatica* Sv.Nilsson y *Phalangispora nawawi* Kuthub.; en la Quebrada Guatopo las especies encontradas fueron *Clavariopsis azlanii* Nawawi, *Condylospora flexuosa* Nawawi & Kuthub. e *Hydrometrospora symmetrica* J.Gönczöl & Révay; para el Río Cabriales las especies fueron *Camposporium antennatum* Harkn., *Phalangispora constricta* Nawawi & J.Webster y *Scorpiosporium chaetocladium* (Ingold) Dyko. Quebrada Martinera y Río Tocomé tienen una especie exclusiva, *Isthmotricladia gombakiensis* Nawawi y *Flabellospora verticillata* Alas., respectivamente. El Río Cúpira y la Quebrada Ingenio no presentaron especies únicas. Se reportan 30 especies por primera vez para el país.

Palabras clave: Cursos de agua, Hifomicetes acuáticos, Parques Nacionales, Venezuela

ABSTRACT

Fifty species of aquatic hyphomycetes from seven streams, six of which are located in Venezuelan National Parks are reported. Community similarity of hyphomycetes was low since only four species were common to all sites: *Campylospora chaetocladia* Ranzoni, *Clavatospora tentacula* Sv.Nilsson, *Triscelophorus acuminatus* Nawawi and *Triscelophorus monosporus* Ingold. The streams had unique species whose number varies between one

and three. In Río Los Castillos the species were: *Anguillospora longissima* (Sacc. & P.Syd.) Ingold, *Angulospora aquatica* Sv.Nilsson and *Phalangispora nawawi* Kuthub.; for Quebrada Guatopo the species were *Clavariopsis azlanii* Nawawi, *Condylospora flexuosa* Nawawi & Kuthub. and *Hydrometrospora symmetrica* J.Gönczöl & Révay; for Río Cabriales the species were *Camposporium antennatum* Harkn., *Phalangispora constricta* Nawawi & J.Webster, *Scorpiosporium chaetocladium* (Ingold) Dyko. Quebrada Martinera and Río To come had one species unique *Isthmotricladia gombakiensis* Nawawi and *Flabellospora verticillata* Alas., respectively. Río Cúpira and Quebrada Ingenio do not have species exclusively to any of them. Thirty species are reported for the first time for the country.

Key words: Aquatic hyphomycetes, National Parks, Streams, Venezuela

INTRODUCTION

Studies on aquatic hyphomycetes have been increasing due to the evidence of their importance on the energy flow of woodland streams (Baldy *et al.* 1995; Gulis & Suberkropp 2003; Methvin & Suberkropp 2003). In general, these studies have been taxonomical, which are few and have been conducted mainly in temperate streams (Sridhar *et al.* 1992; Schoenlein-Crusius & Piccolo 2003), or ecological which are more numerous but also mainly reported for temperate streams. The importance of hyphomycetes on degradation and decomposition of organic matter (allocthonous material) and the utilization by invertebrates (mainly shredders) as a food resource has been well established (Bärlocher & Kendrick 1981; Bärlocher 1992; Gessner & Chauvet 1994, 1997; Baldy & Gessner 1997; Gulis & Suberkropp 2003).

As mentioned before the information available on the description of aquatic hyphomycetes is primarily for streams of the temperate zone (Ingold 1975). Nevertheless, the few studies that have been done in the tropics, regardless of frequency or season, indicated that fungi are widespread and that the species found are mainly restricted to tropical waters (Crane & Dumont 1975; Ranzoni 1979; Sridhar *et al.* 1992; Thomas *et al.* 1992; Santos-Flores & Betancourt-López 1997; Sivichai & Hywel-Jones 1999; Schoenlein-Crusius & Piccolo 2003). Specifically for Venezuela, we have the report made by Nilsson (1962), which did not clearly specify sample sites and the paper by Crane & Dumont (1975) reporting only a new record for Venezuela and South America (*Annelodochium ramulisporum* Deighton). Therefore, due to the importance of the aquatic hyphomycetes and the scarce, sporadic and imprecise information that exist on the hyphomycetes from Venezuela streams, a research project was started with special attention on streams of National Parks. This paper is the first on this research and its objective is to report with great emphasis the aquatic hyphomycetes from different streams of Venezuela.

METHODS

Study area

This study included seven streams located along the Cordillera de la Costa, one of the main mountain ranges of Venezuela. Six of the rivers and mountain streams are located in National Parks (Quebrada Martinera, Quebrada Guatopo, Quebrada Ingenio, Río Tocome, Río Cabrales and Río Cupira), while Río Los Castillos ($10^{\circ}29'54''-10^{\circ}32'$ Lat. N, $66^{\circ}41'-66^{\circ}43''$ Long. W) flows through private property (Club Izcaragua, Miranda State), but its headwaters are in El Ávila National Park and are protected of human activities. The first three rivers are located in Guatopo National Park, Miranda State ($9^{\circ}57'-10^{\circ}5'$ Lat. N, $66^{\circ}24'-66^{\circ}30'$ Long. W) and have been the subject of several studies; detailed information on the sampling area is given on Cressa & Senior (1987) and Maldonado *et al.* (2001). Río Tocome ($10^{\circ}31'30.48''$ Lat. N, $66^{\circ}54'37.2''$ Long. W) runs through the Parque Los Chorros, a locality on the south face of El Ávila National Park, Miranda State (facing Caracas). Cabrales ($10^{\circ}05'16.66''-10^{\circ}21'28.3''$ Lat. N, $67^{\circ}30'10''-68^{\circ}00'$ Long. W) and Cupira rivers ($10^{\circ}13'36.6''-10^{\circ}19'56.6''$ Lat. N, $67^{\circ}56'50''-67^{\circ}58'13.3''$ Long. W) are located in the San Esteban National Park, Carabobo State ($10^{\circ}17'0''-10^{\circ}31'10''$ Lat. N, $67^{\circ}52'30''-68^{\circ}5'10''$ Long. W). Even though all streams are located in protected areas, Quebrada Martinera (M), Quebrada Guatopo (GT) and Río Tocome (T) are subject to the influence of human recreational activities. Quebradas in Guatopo National Park and Izcaragua were sampled throughout 2002 and the rivers in San Esteban National Park were sampled during 2005. In general the vegetation in all the sampling places could be classified as submontane umbrophylus forest and seasonal semi-deciduos (Huber & Alarcón 1988).

Hyphomycetes collection

Water samples

Water samples were collected in polyethylene bottles (500 ml), two per sample site, added lactophenol and kept in a cooler until being processed. In the laboratory water was filtered (Millipore HA, $0.45\ \mu\text{m}$) and the filter was placed on a Petri dish, soaked with 1-2 ml of lactophenol-fucine solution and sterilized water. After 24 h each filter was scrubbed and washed and the suspension centrifuged, placed on a concave slide and the material examined under a microscope.

Foam samples

Foam samples (three per sample site) were collected with a sterile spatula, stored in sterile Petri dishes and kept in a cooler. Once in the laboratory, a solution of lactophenol-fucine was added to stain the conidia and slides were prepared to be examined under the microscope.

RESULTS AND DISCUSSION

The data presented is the summary of the examination of all samples with the methods described above. A total of 50 species were found with the following ranking for the sampling sites: Cabriales (34), Tocomé (33), Los Castillos (33), Cúpira (31), Guatopo (26), Martinera (16), and Ingenio (14) (Table 1). Similarity among sites is low since only four species were found at all sites: *Campylospora chaetocladia* Ranzoni (Fig. 1a), *Clavatospora tentacula* Sv.Nilsson (Fig. 1b), *Triscelophorus acuminatus* Nawawi and *Triscelophorus monosporus* Ingold. Río Los Castillos, Cabriales and Quebrada Guatopo are the streams with more unique species since each one of them had three species that were not found in any of the other streams sampled. In Río Los Castillos the species were *Anguillospora longissima* (Sacc. & P.Syd.) Ingold, *Angulospora aquatica* Sv.Nilsson and *Phalangispora nawawi* Kuthub. (Fig. 1c), for Quebrada Guatopo the species were *Clavariopsis azlanii* Nawawi, *Condylospora flexuosa* Nawawi & Kuthub. (Fig. 1d) and *Hydrometrospora symmetrica* J.Gönczöl & Révay (Fig. 1e) while for Río Cabriales the species were *Camposporium antennatum* Harkn., *Phalangispora constricta* Nawawi & J.Webster, *Scorpiosporium chaetocladium* (Ingold) Dyko. On the other hand, Quebrada Martinera and Río Tocomé had one species unique to each site: *Isthmotricladia gombakiensis* Nawawi (Fig. 1f) and *Flabellospora verticillata* Alas. (Fig. 1g). On the other hand, Río Cúpira and Quebrada Ingenio did not have any exclusive species. Finally, of 50 species found, 30 are reported for the first time for Venezuela.

Table 1. Species of aquatic hyphomycetes in several streams of Venezuela.

Species	Quebrada Guatopo	Quebrada Ingenio	Quebrada Martinera	Río Tocomé	Río Los Castillos	Río Cabriales	Río Cúpira
<i>Actinospora megalospora</i> Ingold	*	*	*		*		
<i>Alatospora acuminata</i> Ingold	*		*	*	*	*	*
<i>Anguillospora crassa</i> Ingold				*	*		
<i>Anguillospora filiformis</i> Greath.			*	*	*	*	*
<i>Anguillospora longissima</i> (Sacc. & P.Syd.) Ingold					*		
<i>Angulospora aquatica</i> Sv.Nilsson					*		
<i>Articulospora tetracladia</i> Ingold	*			*	*	*	*
<i>Beltrania rhombica</i> Penz.		*		*	*	*	*
<i>Beltraniella portoricensis</i> (F.Stevens) Piroz. & Patil		*		*			
<i>Brachiosphaera tropicalis</i> Nawawi	*	*			*	*	*

Table 1. Continuation...

Species	Quebrada Guatopo	Quebrada Ingenio	Quebrada Martinera	Río Tocome	Río Los Castillos	Río Cabriales	Río Cúpira
<i>Camposporium antennatum</i> Harkn.						*	
<i>Camposporium pellucidum</i> (Grove) S.Hughes	*			*	*	*	*
<i>Campylospora chaetocladia</i> Ranzoni	*	*	*	*	*	*	*
<i>Campylospora filicladia</i> Nawawi	*		*	*	*	*	*
<i>Campylospora parvula</i> Kuzuha						*	*
<i>Clavariopsis aquatica</i> De Wild.				*		*	
<i>Clavariopsis azlanii</i> Nawawi	*						
<i>Clavatospora tentacula</i> Sv.Nilsson	*	*	*	*	*	*	*
<i>Condylospora flexuosa</i> Nawawi & Kuthub.	*						
<i>Culicidospora grvida</i> R.H.Petersen	*			*	*	*	*
<i>Diplocladiella longibrachiata</i> Nawawi & Kuthub.		*		*	*	*	*
<i>Diplocladiella scalaroides</i> Arnaud ex M.B.Ellis	*	*		*	*	*	*
<i>Diplocladiella</i> sp.							
<i>Flabellospora acuminata</i> Descals	*		*	*		*	*
<i>Flabellospora crassa</i> Alas.			*	*		*	*
<i>Flabellospora tetracladia</i> Nawawi			*			*	*
<i>Flabellospora verticillata</i> Alas.				*			
<i>Flagellospora curvula</i> Ingold	*		*	*	*	*	*
<i>Helicomycetes colligatus</i> R.T. Moore						*	*
<i>Helicomycetes</i> sp.	*		*	*	*	*	*
<i>Helicomycetes torquatus</i> L.C. Lane & Shearer	*			*	*	*	*
<i>Heliscus submersus</i> H.J.Huds.	*	*		*	*	*	*
<i>Hydrometrospora symmetrica</i> J.Gönczöl & Révay	*						
<i>Isthmotricladiella gombakiensis</i> Nawawi			*				

Table 1. Continuation...

Species	Quebrada Guatopo	Quebrada Ingenio	Quebrada Martinera	Río Tocome	Río Los Castillos	Río Cabriales	Río Cúpira
<i>Jaculispora submersa</i> H.J. Huds. & Ingold	*	*		*	*	*	*
<i>Lunulospora curvula</i> Ingold	*			*	*	*	*
<i>Mycocentrospora acerina</i> (R.Hartig) Deighton			*	*	*		
<i>Phalangispora constricta</i> Nawawi & J.Webster					*	*	
<i>Phalangispora nawawi</i> Kuthub.							
<i>Scorpiosporium angulatum</i> (Ingold) S.H.Iqbal						*	*
<i>Scorpiosporium chaetocladium</i> (Ingold) Dyko						*	
<i>Scutisporus brunneus</i> K.Ando & Tubaki	*	*		*	*	*	*
<i>Tetracladium marchalianum</i> De Wild.	*		*	*	*	*	*
<i>Tetracladium maxiliforme</i> (Rostr.) Ingold				*	*		
<i>Tetracladium setigerum</i> (Grove) Ingold				*	*		*
<i>Tricladium splendens</i> Ingold	*			*	*	*	*
<i>Tricladium</i> sp.		*		*	*		
<i>Triscelophorus acuminatus</i> Nawawi	*	*	*	*	*	*	*
<i>Triscelophorus curviramifer</i> Matsush.				*	*		
<i>Triscelophorus monosporus</i> Ingold	*	*	*	*	*	*	*

Schoenlein-Crusius & Piccolo (2003) indicated that *Anguillospora longissima* (Sacc. & P. Syd.) Ingold, *Articulospora tetracladia* Ingold, *Clavariopsis aquatica* (De Wild.) Ingold, *Lunulospora curvula* Ingold, and *Triscelophorus monosporus* Ingold were the most common species for several countries of South America (Argentina, Brazil, Chile, Ecuador, Peru and Venezuela). Even though all these species were found in some of the streams sampled, only *Triscelophorus monosporus* coincide as the most common. Interestingly enough, Schoenlein-Crusius & Piccolo (2003) reported *Lunulospora curvula* as the most common species.

Finally, comparing these results with those of Nilsson (1962) it was found that of 11 species noted by them for Venezuela, 8 were also reported in this study

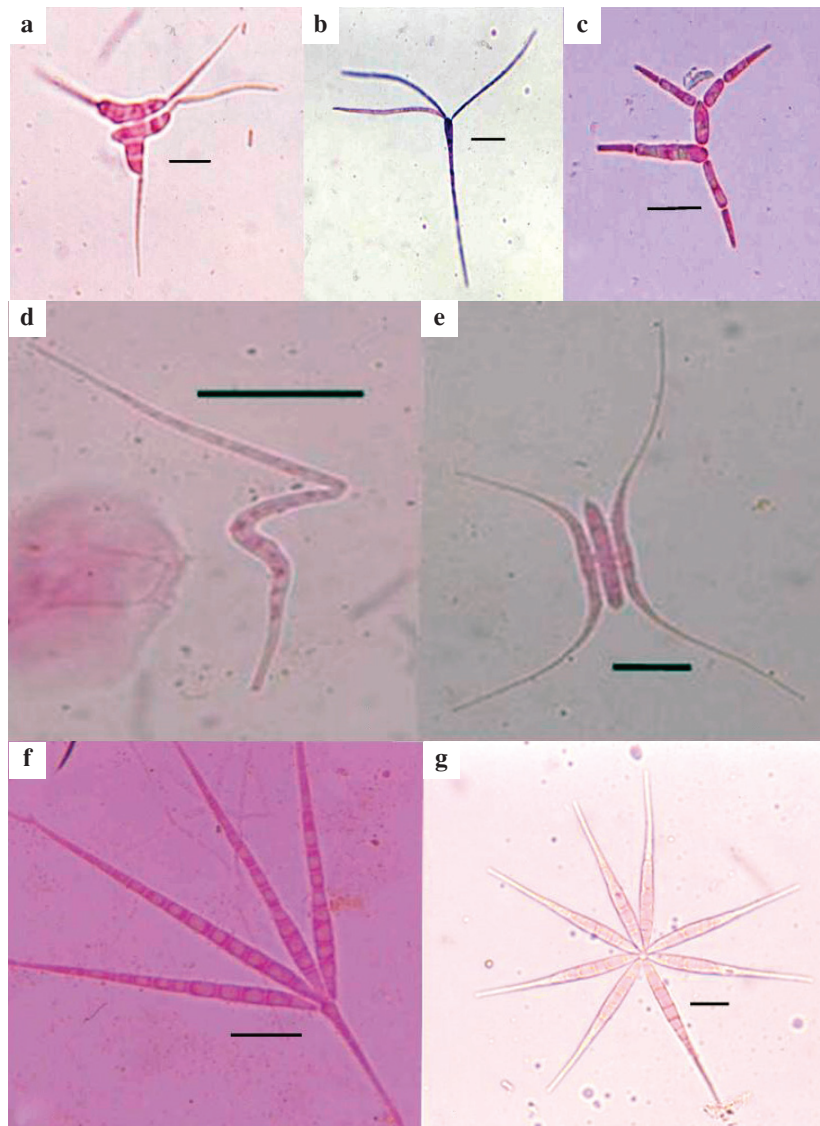


Fig. 1. Conidia of some of the hyphomycetes studied. **a.** *Campylospora chaetocladia* from Río Tocomé. **b.** *Clavatospora tentacula*. **c.** *Phalangispora nawawi* from Río Los Castillos. **d.** *Condylaspera flexuosa* from Quebrada Guatopo. **e.** *Hydrometrospora symmetrica* from Quebrada Guatopo. **f.** *Isthmotricladia gombakiensis* from Quebrada Martinera. **g.** *Flabellospora verticillata* from Río Tocomé. Scale = 10 μ m.

(Table 2). Smits and Cressa (2005) reported 21 species for the Río Los Castillos (Table 2) but this study now reports 33 species (Table 1). Similarly, Fernández & Smits (2005) reported for the Río Cabriales 15 species to which 19 from the present study must be added. Therefore, in this paper 30 species are reported for the first time for Venezuela (Table 3). This study covers just few of the many rivers located on one of the Venezuela regions (Cordillera Central, PDVSA 1992), thus it is not surprising that much more species should be reported in the future.

Table 2. Comparison between the species of aquatic hyphomycetes reported by Nilsson (1962) and the ones found in this study.

Species	Nilsson (1962)	This paper
<i>Anguillospora longissima</i> (Sacc. & P.Syd.) Ingold	*	*
<i>Angulospora aquatica</i> Sv.Nilsson	*	*
<i>Articulospora tetracladia</i> Ingold	*	*
<i>Campylospora chaetocladia</i> Ranzoni	*	*
<i>Dactylella aquatica</i> (Ingold) Ranzoni	*	
<i>Flagellospora penicillioides</i> Ingold	*	
<i>Heliscus submersus</i> H.J.Huds.	*	*
<i>Lumulospora curvula</i> Ingold	*	*
<i>Pyramidospora casuarinae</i> Sv.Nilsson	*	
<i>Tetracladium marchalianum</i> De Wild.	*	*
<i>Triscelophorus monosporus</i> Ingold	*	*

Table 3. Species of aquatic hyphomycetes reported by Smits & Cressa 2005 from Río Los Castillos (LC) and the new records reported in this paper for all sampled streams.

Species	Smits & Cressa (2005)	New reports for LC	New records (this paper)
<i>Actinospora megalospora</i> Ingold	*		
<i>Alatospora acuminata</i> Ingold	*		
<i>Anguillospora crassa</i> Ingold	*		
<i>Anguillospora filiformis</i> Greath.	*		
<i>Anguillospora longissima</i> (Sacc. & P.Syd.) Ingold		*	*
<i>Angulospora aquatica</i> Nilsson		*	*
<i>Articulospora tetracladia</i> Ingold	*		
<i>Beltrania rhombica</i> Penz.	*		
<i>Beltraniella portoricensis</i> (F.Stevens) Piroz. & Patil		*	
<i>Brachiosphaera tropicalis</i> Nawawi	*		
<i>Camposporium antennatum</i> Harkn.			*
<i>Camposporium pellucidum</i> (Grove) S.Hughes		*	*

Table 3. Continuation...

Species	Smits & Cressa (2005)	New reports for LC	New records (this paper)
<i>Campylospora chaetocladia</i> Ranzoni	*		
<i>Campylospora filicladia</i> Nawawi	*		
<i>Campylospora parvula</i> Kuzuha			*
<i>Clavariopsis aquatica</i> De Wild.			*
<i>Clavariopsis azlanii</i> Nawawi			*
<i>Clavatospora tentacula</i> Sv.Nilsson	*		
<i>Condylospora flexuosa</i> Nawawi & Kuthub.			*
<i>Culicidospora gravida</i> R.H.Petersen	*		*
<i>Diplocladiella longibrachiata</i> Nawawi & Kuthub.	*		
<i>Diplocladiella scalaroides</i> Arnaud ex M.B.Ellis	*		
<i>Diplocladiella</i> sp.			*
<i>Flabellospora acuminata</i> Descals			*
<i>Flabellospora crassa</i> Alas.			*
<i>Flabellospora tetracladia</i> Nawawi			*
<i>Flabellospora verticillata</i> Alas.			*
<i>Flagellospora curvula</i> Ingold	*		
<i>Helicomyces colligatus</i> R.T.Moore			*
<i>Helicomyces</i> sp.		*	*
<i>Helicomyces torquatus</i> L.C.Lane & Shearer		*	*
<i>Heliscus submersus</i> H.J.Huds.	*		
<i>Hydrometrospora symmetrica</i> J.Gönczöl & Révay			*
<i>Isthmotricladia gombakiensis</i> Nawawi			*
<i>Jaculispora submersa</i> H.J.Huds. & Ingold		*	*
<i>Lunulospora curvula</i> Ingold		*	*
<i>Mycocentrospora acerina</i> Deighton	*		
<i>Phalangispora constricta</i> Nawawi & J.Webster			*
<i>Phalangispora nawawi</i> Kuthub.		*	*
<i>Scorpiosporium angulatum</i> (Ingold) S.H.Iqbal			*
<i>Scorpiosporium chaetocladium</i> (Ingold) Dyko			*
<i>Scutisporus brunneus</i> K.Ando & Tubaki		*	*
<i>Tetracladium marchalianum</i> De Wild.	*		
<i>Tetracladium maxiliforme</i> (Rost.) Ingold		*	*
<i>Tetracladium setigerum</i> (Grove) Ingold	*		
<i>Tricladium splendens</i> Ingold		*	*
<i>Tricladium</i> sp.		*	*
<i>Triscelophorus acuminatus</i> Nawawi	*		
<i>Triscelophorus curviramifer</i> Matsush.	*		
<i>Triscelophorus monosporus</i> Ingold	*		

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