Frequency and abundance of zoosporic fungi in some lotic environments of Buenos Aires Province (Argentina)

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Zoosporic fungi are common inhabitants of aquatic environments; however, there are few quantitative studies made for Argentinean streams. In this contribution, the frequency of occurrence and abundance of zoosporic fungi were quantified in three lotic environments of the Río de La Plata system, using the baiting technique. Eight genera were recovered (*Achlya, Aphanomyces*, *Dictyuchus*, *Olpidiopsis, Phytophthora, Pythium, Rhizophlyctis* and *Saprolegnia*) and their patterns of frequency and abundance distribution show certain similarities in the streams analyzed.

Key words: abundance, Argentina, frequency, streams, zoosporic fungi

Introduction

Zoosporic fungi are universally present in all types of freshwater systems and occur as saprotrophs on a wide variety of substrata, playing a key role in those ecosystems as decomposers of organic materials (Müeller *et al*., 2004).

Most studies dealing with zoosporic fungi have provided extensive inventories of taxa from specific sites or geographic regions, but often without characterizing the microhabitat, determining frequencies of occurrence or relative abundance of species (Coker, 1927; Scott, 1961; Sparrow, 1960; Karling, 1977).

Far less work has been carried out on the ecology of the zoosporic fungi in rivers and streams than in lentic habitats (Johnson *et al*., 2002). The scarce information about zoosporic fungi communities in neotropical streams comes from investigations of Shoenlein-Crusius and Milanez (1998a,b) and Schoenlein-Crusius *et al*. (1998, 1999).

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Not only is the ecology of zoosporic fungi limited, but the ecology of fungal stream communities as a whole is lacking because of the omission of these ubiquitous organisms (Letcher and Powell, 2001).

In Argentina, little quantitative information of these fungi is available (Steciow, 1996, 1997a,b; Marano and Steciow, 2005) and studies elucidating their occurrence and distribution are required.

The aim of this paper is to analyze and compare the frequency and abundance patterns of the genera recovered in three lotic systems (Don Carlos, Rodríguez and Martín streams) belonging to the Buenos Aires Province (Argentina).

Materials and methods

Three lotic systems belonging to the Río de La Plata littoral region were selected in La Plata surroundings (Buenos Aires Province, Argentina). In this case we chose the upstream sections of the Rodríguez stream (34° 56´ 49" S- 58° 05´ 12" W) and their affluent, the Don Carlos stream (34° 55´ S- 58° 00´ W). In the sampling sites both streams lack of autochthonous riparian vegetation and are subjected to agriculture and cattle farming (Bauer *et al*., 2002; Licursi and Gómez, 2002; Tolcach and Gómez, 2002).

The Martín stream belongs to the Carnaval-Martín system which covers an area of 123,6 km in La Plata and Ensenada districts (Buenos Aires Province, Argentina). It is located 13 km NE of La Plata and in the middle part runs through a Municipal Ecological Park. The sampling site in this case is located downstream of this park (34° 51´ 54" S- 58° 03´ 77" W) and it is affected by a number of degradation processes such as urbanization, industrialization and recreation activities (Hurtado *et al*., 2001) (Fig. 1).

Surface water samples of 20 ml each with suspended organic matter were collected on September 2005 from five different points of each site, and brought back to the laboratory in sterile polyethylene bags. The water temperature and pH value were recorded at those sites.

For the isolation of zoosporic fungi the baiting technique was used (Sparrow, 1960; Stevens, 1974). Water samples of each site were put together (100 ml) and four aliquots of 25 ml were placed in 9 cm Petri dishes with four sterile baits (sesame seeds and pieces of snake skin of 5 mm of diameter). Water cultures were incubated at room temperature (20-25°C) for 4-7 days.

Generic identification was made according to Coker (1923), Johnson (1956), Sparrow (1960), Scott (1961), Karling (1977) and Johnson *et al*. (2002).

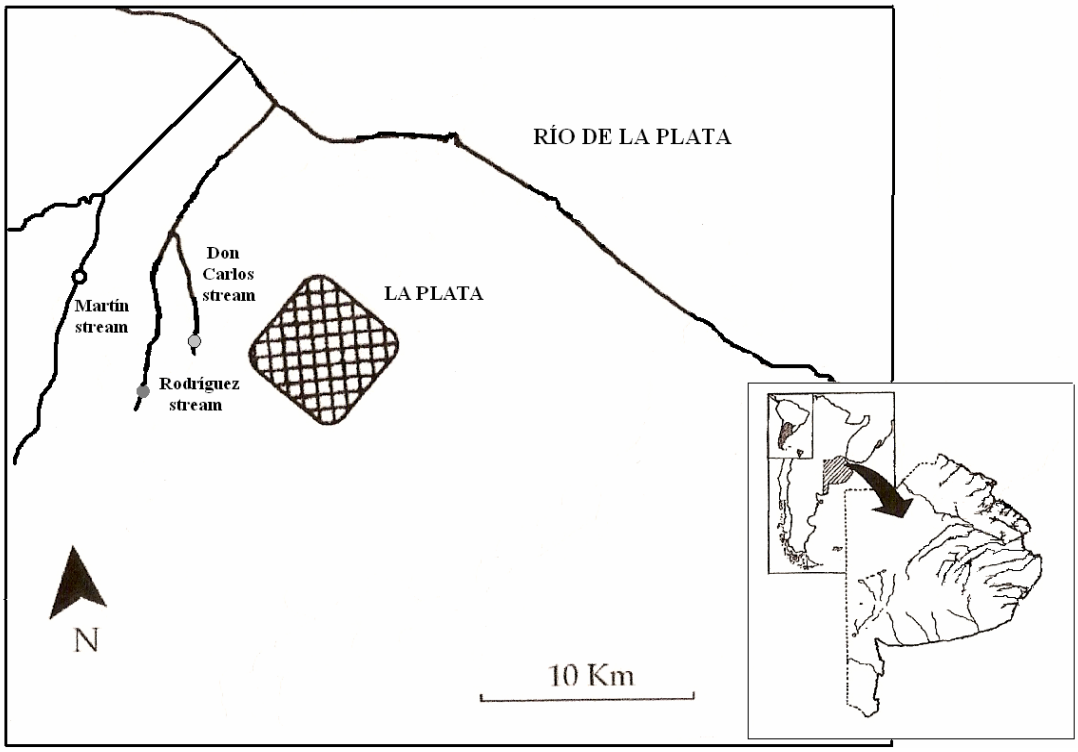

Fig. 1. Study area: Don Carlos, Rodríguez and Martín streams (circles indicate sampling sites).

Presence–absence (occurrence) of a genus in each Petri dish was recorded. Relative frequency (%) was calculated as: number of dishes in which a genus is present/ number of dishes examined ×100 (Letcher and Powell, 2001; Yanna *et al*., 2001).

The Braun-Blanquet scale was used to place genera into five frequency groupings: ubiquitous: 100-80, 1% occurrence; common: 80-60,1% occurrence; often present: 60-40,1% occurrence; scarce: 40-20,1% occurrence and rare: 20-0,1% occurrence (Kershaw, 1973; Letcher and Powell, 2001, 2002).

Because of the few methods developed to quantify zoosporic fungi abundance (Zhang *et al*., 1998), we establish two different ways of calculating the relative abundance of a genus: in the first, each genus that appeared in a dish was counted as a colony and rated to the total number of isolations for each site and in the second one, each bait colonized by a genus was recorded as an isolation and then the relative abundance (%) was calculated as the summitry of baits colonized by a genus in relation with the number of isolations of all the genera present (Yanna *et al*., 2001).

A similarity index (Sorensen‘s index) was calculated between the streams analyzed, according to Iqual (1994), Sarma *et al*. (2001) and Müeller *et al*. (2004):

Sorensen’s index = 2c/ a + b
a: the number of genera in the stream A
b: the number of genera in the stream B
c: the number of genera in common in stream A and B

Results

The pH and water temperature showed similar values in the streams analyzed (Table 1).

Table 1. pH value and water temperature in the streams analyzed.

Stream	pH	Temperature (°C)
Martín stream	6.71	21.3
Don Carlos stream	6.54	21.8
Rodríguez stream	7.33	20.4

A total of 115 isolations of zoosporic fungi were made, and of these isolations 91% correspond to members of the Peronosporomycota and only 9% to Chytridiomycota. Between the Peronosporomycota, the Saprolegniomycetidae were more abundant (93%) than the Peronosporomycetidae (7%). A total of eight genera were recovered, which seven of them belonging to the Peronosporomycota: *Aphanomyces*, *Saprolegnia, Achlya, Dictyuchus*, *Pythium, Phytophthora and Olpidiopsis*. Only *Rhizophlyctis* was found within the Chytridiomycota.

Five species were identified: *Aphanomyces scaber* de Bary, *Achlya radiosa* Maurizio, *Dictyuchus monosporus* Leitgeb, *Olpidiopsis pythii* (Butler) Karling and *Rhizophlyctis rosea* (de Bary and Woronin) Fischer. The genus *Dictyuchus* was only represented by *D. monosporus*, *Olpidiopsis* only by *O. pythii* and *R. rosea* was the only species isolated for the genus *Rhizophlyctis*.

According to the Braun-Blanquet scale for frequency groupings, *A. scaber* was a common species found in the Rodríguez stream that represents 27% of the isolations made for this stream; *A. radiosa* was a scarce isolated species in Don Carlos stream with 14% of abundance. *Dictyuchus monosporus* was found in all the sampling sites and was an ubiquitous species in the

Rodríguez stream (100% of occurrence) and was common to found it in the Don Carlos stream (75% of occurrence), but it was less frequent in the Martín stream (50% of occurrence). *Olpidiopsis pythii* was found only once in the Don Carlos stream with an abundance of 1% (Fig. 2).

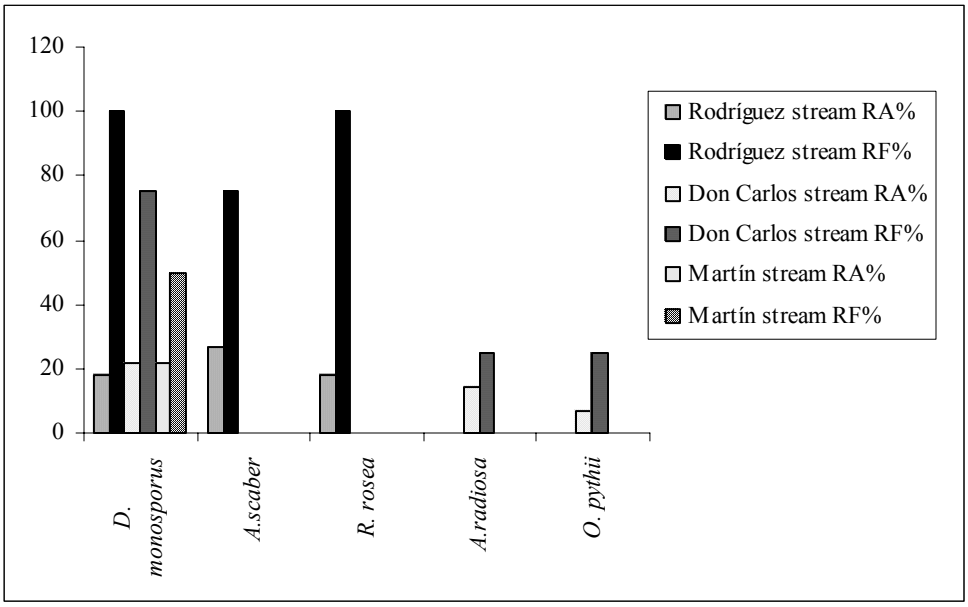

Fig. 2. Relative abundance (RA%) and relative frequency (RF%) of the species identified.

The site with greater abundance of zoosporic fungi was the Rodríguez stream (55 isolations) accounting for 49% of the total and in the Don Carlos and Martín streams the number of isolations was much lower (33 and 27 isolations; respectively 29% and 23% of the total number of isolations). The similarity index calculated was higher between the Rodríguez and Don Carlos streams (77%) than the Rodríguez- Martín (67%), and finally the less similar fungal communities were those of the Don Carlos and Martín streams (60%).

The genera composition at the three sites was similar but not identical, and the percent of occurrence and the relative abundance varied among the different sites (Figs. 3a,b). The abundance of *Saprolegnia* and *Aphanomyces* was much greater in the Martín stream (45% and 33% respectively) than in the Don Carlos or Rodríguez stream both genera reach an abundance range of 18-21% of the isolations. In the Martín stream only three genera were recovered: *Aphanomyces*, *Dictyuchus* and *Saprolegnia* that was the most abundant genus found in this sampling site.

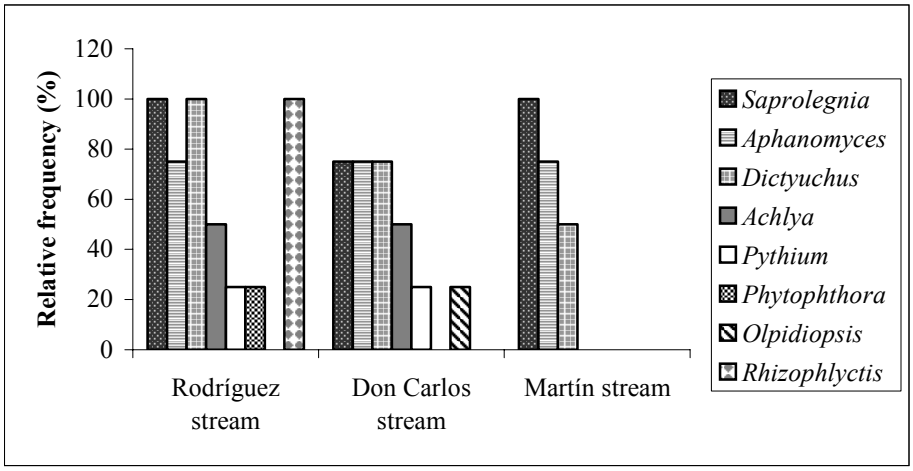

Fig 3a. Frequency of occurrence (%) of the genera present in each sampling site.

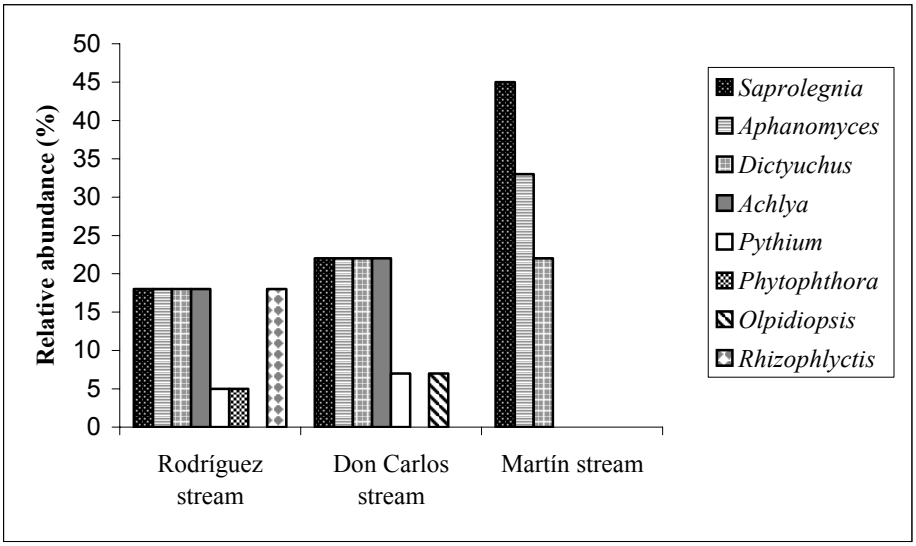

Fig. 3b. Relative abundance (%) of the genera in each stream analyzed.

In the samples collected from the Rodríguez stream, four of the seven genera recovered (*Dictyuchus*, *Saprolegnia*, *Aphanomyces* and *Rhizophlyctis*) were ubiquitous, showing 75-100% of occurrence and the same abundance (18%).

In the Don Carlos stream, those genera were common to be found (they were less abundant than in the Rodríguez stream) and had the same abundance (22%).

Achlya was often present in the Rodríguez and Don Carlos streams and had the same abundance (50%) of *Saprolegnia*, *Aphanomyces* and *Dictyuchus* but was not as frequent as these genera. *Saprolegnia* and *Aphanomyces* were the most frequently and abundant (45% and 33% respectively) isolated genera if we consider the three sampling sites (Table 2a,b).

Table 2a. Abundance distribution recorded as each genus that appeared in a dish counted as a colony and rated to the total number of isolations in each sampling site.

	Rodríguez stream		Don Carlos Stream		Martín stream	
	Number isolations	Relative abundance (%)	Number isolations	Relative abundance (%)	Number isolations	Relative abundance (%)
Aphanomyces	4	25	3	21,5	3	44
Saprolegnia	4	25	3	21,5	4	33
Dictyuchus	2	12,6	3	21,5	2	22
Achlya	2	12,6	3	21,5	0	0
Pythium	1	6	0	0	0	0
Phytophthora	1	6	0	0	0	0
Olpidiopsis	0	0	1	7	0	0
Rhizophlyctis	2	12,6	1	7	0	0
	16		**14**		**9**	

As it is shown in Fig. 4, *Saprolegnia* was the most abundant genus present in this survey (33%), followed by *Dictyuchus* and *Aphanomyces* (22% and 20% of relative abundance respectively).

Discussion

Those similar but separate aquatic habitats studied have approximately the same genera composition but vary in their frequency of occurrence and abundance distribution.

The findings here show that zoosporic fungi, which exhibited high frequencies, also exhibited high values of abundance. These frequently found fungi could be considered as indicators of the genera composition of these water bodies. Ubiquitous and common genera, in this case *Saprolegnia*,

Table 2b. Abundance distribution of the genera in each sampling site: the relative abundance (%) was calculated as the summitry of baits colonized by a genus in relation with the number of isolations of all the genera present.

Rodríguez stream Number of dishes examined:	**1**	**2**	**3**	**4**	**∑**
Aphanomyces	++	++	+++	++++	11
Saprolegnia	++++	++++	++++	+++	15
Dictyuchus	+++	++	+++	+	9
Achlya	+++	+	-	+++	7
Pythium	++++	-	-	-	4
Phytophthora	+++	-	-	-	3
Olpidiopsis	-	-	-	-	0
Rhizophlyctis	+++	+	+	+	6
Total					**55**
Don Carlos stream Number of dishes examined:	**1**	**2**	**3**	**4**	**∑**
Aphanomyces	++	+	-	++	5
Saprolegnia	+++	+	-	++++	8
Dictyuchus	++++	-	+++	++++	11
Achlya	-	++++	+++	-	7
Pythium	-	-	+	-	1
Phytophthora	-	-	-	-	0
Olpidiopsis	-	-	+	-	1
Rhizophlyctis	-	-	-	-	0
Total					**33**
Martín stream Number of dishes examined:	**1**	**2**	**3**	**4**	**∑**
Aphanomyces	+++	++	-	++	7
Saprolegnia	+++	++++	++++	++++	15
Dictyuchus	+++	-	-	++	5
Achlya	-	-	-	-	0
Pythium	-	-	-	-	0
Phytophthora	-	-	-	-	0
Olpidiopsis	-	-	-	-	0
Rhizophlyctis	-	-	-	-	0
Total					**27**

The number of + is related with the number of baits colonized (isolations).
∑: summary of baits colonized (number of isolations for each genus).

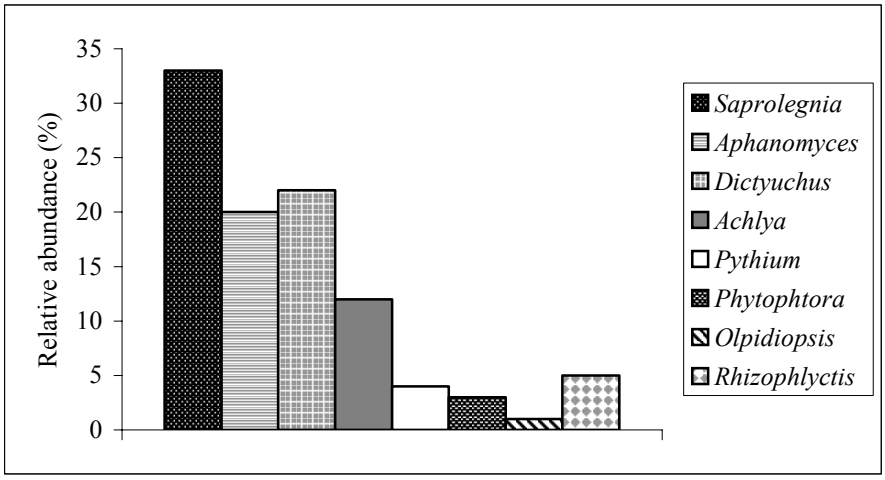

Fig. 4. Relative abundance (%) of the genera present in this study.

Aphanomyces and *Dictyuchus* characterized community structure while scarce to rare genera like *Pythium*, *Phytophthora* or *Olpidiopsis* determined the diversity of the streams analyzed. The total number of genera recovered and their abundance distribution in each site also contributes to zoosporic fungi diversity.

Several frequency groupings were used to characterize members of a fungal community (Hyde, 1989; Leong *et al*., 1991; Sarma *et al*., 2001); in this study we have chosen the Braun-Blanquet scale to characterize zoosporic fungi communities according to Letcher and Powell (2001; 2002).

Some of the taxa found in this survey, were previously isolated in other studies of zoosporic fungi communities in the neotropics (Schoenlein-Crusius *et al*., 1992), and species like *Achlya radiosa* and *Rhizophlyctis rosea* were recovered in the same month (September) on *Alchornea triplinervia* and *Ficus microcarpa* leaves in Brazilian streams (Schoenlein-Crusius *et al*., 1992) and on decomposed organic debris in the Río Santiago (Ensenada district, Buenos Aires) (Steciow, 1992).

El-Hissy *et al*. (1982) and El-Hissy and Khallil (1989) reported that zoosporic fungal communities in freshwater habitats are mainly composed of *Saprolegnia, Dictyuchus, Achlya* and *Pythium*. In our study this was in accordance with the results obtained for the Don Carlos and Rodríguez streams, but in this case *Aphanomyces* was also a common fungus. According to Yanna *et al.* (2002), *Saprolegnia*, *Dictyuchus*, *Achlya* and *Aphanomyces*, which showed a relative abundance greater than 10%, are regarded as dominant species. Certain scarce genera like *Pythium*, *Phytophtora* or *Olpidiopsis* were not found in the Martín stream and only three ubiquitous to often-present fungi,

in this case *Saprolegnia*, *Dictyuchus* and *Aphanomyces*, were dominant at this site. Those dominant genera together with *Achlya*, that was also a dominant genus in the Rodríguez and Don Carlos streams, contributed to the high values of the similarity index of Sorensen's that exhibit the streams analyzed. Based upon this index, there are little differences between the zoosporic mycota of the Rodríguez and Don Carlos streams. According to Christensen (1989), a similarity index greater than 70% indicate that those are closer fungal communities. Both streams were more similar in the genera composition between them than with the Martín stream; this result was expectable because the Don Carlos stream is an affluent of the Rodríguez stream.

These are preliminary observations on the zoosporic fungal communities on some streams belonging to the Río de La Plata system, but clearly more intensive and detailed sampling protocols and systematic accounts are necessary to identify patterns of distribution and to characterize these communities as a whole.

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