Brazilian Journal of Microbiology (2006) 37:267-275
ISSN 1517-8382

MICROSCOPIC FUNGI IN THE ATLANTIC RAINFOREST IN CUBATÃO, SÃO PAULO, BRAZIL

Iracema Helena Schoenlein-Crusius*; Adauto I. Milanez; Sandra F.B. Trufem; Carmen L.A. Pires-Zottarelli; Rosely A. Piccolo Grandi; Maria L. Santos; Kátia C. Giustra

Instituto de Botânica, Seção de Micologia e Liquenologia, São Paulo, SP, Brasil

Submitted: March 16, 2005; Returned to authors for corrections: January 30, 2006; Approved: April 19, 2006

ABSTRACT

This article presents a survey of fungi obtained from soil, water and mixed leaf litter samples taken from the Atlantic Rainforest in the municipality of Cubatão, in the State of São Paulo, during the years of 1993 to 1995. Using different techniques for the isolation of microscopic fungi, a total of 280 taxa was obtained (66 zoosporic fungi, 40 Mucorales, 45 Glomales, 125 anamorphs, three Ascomycota and one Basidiomycota), with 23 species being reported for the first time in Brazil.

Key words: fungi, diversity, Atlantic Rainforest, Brazil

INTRODUCTION

The Brazilian Atlantic Rainforest has been recognized as of top priority for conservation in South America because of the high degree of endemism in several groups of organisms (30). In the State of São Paulo, the diversity of several groups of fungi is better known because surveys have been done in terrestrial and aquatic environments in some preserved or less affected Atlantic Rainforest in protected areas such as "Reserva Biológica de Paranapiacaba" (1,19,23,25,55-59,69), "Parque Estadual da Ilha do Cardoso" (66,67,68,71,72) and "Estação Ecológica da Juréia-Itatins" (2,12,22,42), but also in regions relatively close (10 to 20km) to the center of the city of São Paulo, such as "Represa do Guarapiranga" (14,32,50,51,75) and "Parque Estadual das Fontes do Ipiranga", where the Botanical Institute of São Paulo is located (16,17,20,24,36-41,44-46,54,70,73).

The Cubatão region has become an important Brazilian industrial complex since the 50s'. The uncontrolled construction of fertilizer, dyes, steel and petroleum plants has caused increasing air, water and soil pollution affecting native fauna and flora, and causing severe human health problems. Compound such as fluorides, ammonium, hydrocarbons, nitrogen and sulfur oxides, and particulate matter are the main pollutants (30,61).

In view of the need for monitoring and recovering the environmental quality of Cubatão, studies were undertaken during the last decades on nutrient cycling, bioindicators, bioaccumulators, and pollutant levels in several areas (30,31,33). In this article our objective is to contribute to an overall prospective of the present knowledge of the fungal diversity of this region.

MATERIALS AND METHODS

From March 1993 to March 1995, 13 collections of soil, water and leaf litter samples were taken every two months, from ten collection sites in the areas of the "Vale do Rio Mogi" and "Vale do Rio Pilões", for a total of 390 samples.

The investigated area, located at 23º45'- 23º55'and 46º15'30'W, is in the State of São Paulo, in the municipality of Cubatão and includes parts of the coastal plain and of the "Serra do Mar" mountain range. The annual rainfall ranges from 2500 mm on the coast to 4000 mm on the mountain slopes, the relative air humidity being always high (more than 80%) and the mean temperature around 20-25ºC. There is a distinct land/sea wind circulation and stagnating air masses in front of the mountains that are covered by the Atlantic rainforest, which includes several Botanical families such as Melastomataceae, Amarantaceae, Lauraceae, Fabaceae, among others (30).

*Corresponding Author. Mailing address: Instituto de Botânica, Seção de Micologia e Liquenologia, Caixa Postal 4005. 01061-970, São Paulo, SP, Brasil. E-mail: iracema@crusius.com.br

The “Vale do Rio Moji” is an area downwind from the industries of the Cubatão complex. The pollution in this area is mainly caused by fertilizers, steelworks and chemical products industries, increasing the amount of particulate matter, fluorides and compounds of nitrogen and sulfur, and severely affecting the vegetation. In former studies, the area of the “Vale do Rio Pilões”, located about 30km from the other site, was considered a reference site, showing apparently undamaged rainforest vegetation. However further investigations showed that its characterization as less affected by air pollution is more adequate (31).

Water samples (500 mL) with organic matter (twigs, leaves, etc.) were taken from the surface of streams and reservoir in sterile plastic bottles. These samples were distributed into Petri dishes containing several baits: corn straw, cellophane, shrimp shells, pollen grains, snake skin, halves of *Sorghum* sp. seeds and blond human hair (35). After three to five days of incubation at room temperature (20-23ºC) the baits were analyzed under the microscope to search for structures of zoosporic fungi.

Baits colonized by Chytridiomycota were kept in contact with new substrates, whereas colonies of Oomycota grown on the *Sorghum* sp. seeds were transferred to culture media, MP_5 (6) and CMA added with pimaricin, streptomycin sulphate and penicillin (7) for purification. To bait specific taxa of Blastocladiales, Monoblepharidales and Leptomitales, apples placed in plastic containers were submerged at a depth of 20cm and recovered 15 to 21 days later (35). In the laboratory the fruits were washed with tap water and placed in an aquarium containing water composed of 1.5L of local water added to 1.5L of sterile distilled water. Aeration of water was provided by a small pump. The apples were observed daily looking for pustules, containing colonies of Leptomitales and/or Blastocladiales and/or Monoblepharidales.

According to the taxonomical group, slides containing colonized baits, aliquots of cultures or pustules were prepared to be observed under the microscope in order to identify the zoosporic fungi consulting current literature (28,29,47,62-64 beside others).

The soil samples (300 g), were analyzed by three different techniques. Aliquots of the sample were placed in Petri dishes containing sterile distilled water and the above mentioned baits to isolate zoosporic fungi. To obtain terrestrial fungi, the soil-plate method (74) was applied using Martin’s Bengal Rose Medium supplimented with streptomycin (0.5 g/L). The Petri dishes were incubated at 22ºC during five days and then selected colonies were transferred to specific culture media. Colonies of Mucorales were purified on Synthetic Mucor Agar – SMA (27), and anamorphs on Potato Dextrose Agar (PDA).

About 100g of rhizosphere soil taken at a depth of 15-20cm were submitted to the Gerdemann and Nicolson (13) technique, using sieves with a mesh of 53 to 750mm, to obtain spores of arbuscular mycorrhizal fungi (AMF) as well as delicate roots. Soil suspensions taken from the sievings (400mm) were diluted in sucrose solution (50% v/v) and centrifuged at 1.750-2.000 rpm (1 min.) to separate spores, in the liquid phase, from the remains. The spores taken from the supernatant were washed several times in sterile distilled water to eliminate sugar residues and preserved in permanent slides mounted with polivinilic alcohol and lactophenol resine - PVL (52), then being observed under the microscope for the identification of the fungal taxa based on morphological taxonomical features (13,52).

The mixed leaf litter samples were treated by the leaf disk washing method, where leaf disks (5mm diam.) are cutted from the samples and washed with sterile distilled water 30 times to eliminate propagules from the leaf surface, improving the obtaintion of leaf-inhabiting fungi (48). In the present study two isolation methods were used afterwards. In the first, the washed leaf disks were directly placed on PDA to promote the obtaintion of fast growing fungi. After three to five days of incubation at 22ºC, the colonies of anamorphs were purified on PDA and those of Mucorales on SMA. Slides of the colonies were prepared with lactophenol - cotton blue for observation under the light microscope to identify the taxa with basis on morphological features (4,5,9-11,53, beside others.)

The other method aimed to obtain fungi that are able to use the decomposing leaves as only nutrient sources. Thus, the remaining washed disks were fragmented, and distributed into ten moist chambers per collection with a hundred leaf litter fragments each (26). The moist chambers were incubated during 30 days at least, and the leaf fragments were daily observed under the stereomicroscope to find fungal structures, which were then isolated and preserved in slides prepared with PVL resine (52) to be observed under the microscope and identified using specific literature for the group (10,11,34, beside others).

The diversity of the anamorphs was documented by microscope slides mounted in PVL resin, and cultures, which were preserved by lyophilization or by the method of Castellani (agar blocks taken from the cultures and submerged in distilled sterile water). The cultures were deposited in the Fungal Culture Collection and the slides in the Herbarium “Maria Eneyda P. Kauffmann Fidalgo (SP), both in the Botanical Institute of São Paulo.

RESULTS AND DISCUSSION

During the survey 280 fungal taxa were obtained, 66 being zoosporic fungi, 40 Mucorales, 45 Glomales, 125 anamorphs, three Ascomycota and one Basidiomycota.

A total number of 66 zoosporic fungi were obtained from soil and water samples (Table 1), 27 being Chytridiomycota and 39 Oomycota, divided into 9 taxa of Blastocladiales, 16 Chytridiales, two Monoblepharidales, two Lagenidiales, two Leptomitales, 11 Peronosporales and 24 Saprolegniales.

Table 1. Zoosporic fungi present (+) in the water and soil in the region of Cubatão. Legend: ◆ new record for Brazil.

Zoosporic fungi		
Chytridiomycota:	Water	Soil
Allomyces anomalus Emerson	+	+
Blastocladia incrassata Indoh	+	-
B. gracilis Kanouse	+	-
B. pringsheimii Reinsch	+	-
B. ramosa Thaxter	+	-
Blastocladia sp.$_1$	+	-
Blastocladia sp.$_2$	+	-
Catenaria anguillulae Sorokin	-	+
Catenochytridium kevorkianii Sparrow	-	+
Catenophlyctis variabilis (Karling) Karling	+	+
Cladochytrium replicatum Karling	+	+
Diplophlyctis sarcoptoides (H.E. Petersen) Dogma	+	+
D. complicata (Willoughby) Dogma ◆	+	-
Diplophlyctis sp.$_1$	+	+
Gonapodya prolifera (Cornu) Fischer	+	-
G. polymorpha Thaxter	+	-
Karlingia dubia Karling ◆	+	+
K. rosea (de Bary & Woronin) Johanson	+	+
Nowakowskiella hemiphaerospora Shanor ◆	+	-
N. multispora Karling ◆	+	-
N. elegans (Nowak.) Schroeter	+	+
Polychytrium aggregatum Ajello	+	-
Rhizophydium keratinophylum Karling	-	+
R. sphaerotheca Zopf	+	+
Rhizophydium elyensis Sparrow	+	+
Rhizophlyctis petersenii Sparrow	-	+
Septochytrium variabile Berdan	+	+
Total number of taxa of Chytridiomycota:	23	15
Oomycota:		
Achlya americana Humphrey	-	+
A. cambrica Trow ◆	-	+
A. flagellata Coker	+	+
A. hypogyna Coker & Paterson ◆	-	+
A. klebsiana Pieters	+	+
A. orion Coker & Couch	+	+
A. oviparvula Rogers & Beneke	+	+
A. prolifera C.G. Nees	+	+
A. proliferoides Coker	+	+
A. radiosa Maurizio	+	-
A. recurva Cornu	-	+
Aphanomyces euteiches Drechsler	+	-
A. laevis de Bary	+	+
A. stellatus de Bary	+	-
Brevilegnia sp.	-	+
Dictyuchus pseudodictyon (Coker & Braxton) ex Couch	-	+
Leptolegniella keratinophila Huneycut	-	+
Olpidiopsis achlyae McLarty	+	-
Olpidiopsis fusiformis Cornu	+	-
Sapromyces androgynus Thaxter	+	-
S. elongatus (Cornu) Coker	+	-
Pythium middletonii Sparrow ◆	+	+
P. monospermum Pringsheim	-	+
P. paroecandrum Dreschler ◆	-	+
P. spinosum Sawada	-	+
P. tardicrescens Vanterpool	+	+
P. torulosum Coker & Patterson	+	+
P. ultimum var. *sporangiferum* Drechsler	+	+
P. vexans de Bary	-	+
Pythium sp. $_1$	+	+
Pythium sp. $_2$	+	+
Phytophthora gonapodyides (H.E. Petersen) Buisman	+	-
Saprolegnia asterophora de Bary ◆	-	+
S. australis Elliot ◆	+	
S. ferax (Gruith.) Thuret	+	-
S. megasperma Coker	+	-
S. parasitica Coker	+	+
S. subterranea Dissman	+	+
Thraustotheca clavata (de Bary) Humphrey	+	+
Total number of taxa of Oomycota:	27	28
Total number of taxa of zoosporic fungi	50	43

Diplophlyctis complicata (Willoughby) Dogma, *Karlingia dubia* Karling, *Nowakowskiella hemiphaerospora* Shanor, *Nowakowskiella multispora* Karling, *Achlya cambrica* Trow, *Achlya hypogyna* Coker & Paterson, *Pythium middletonii* Sparrow, *Pythium paroecandrum* Drechsler, *Saprolegnia asterophora* de Bary and *Saprolegnia australis* Elliot listed here for the Atlantic Rainforest were first reported from Brazil by Pires-Zottarelli (43).

The number of taxa (Table 1) isolated from each compartment (43 isolated from soil and 50 from water samples) were similar to that mentioned for the "Parque Estadual das Fontes do Ipiranga", a remanecent Atlantic Forest area located on the border of São Paulo city, in that 48 taxa of zoosporic fungi were obtained after two years of monthly collections of water and soil samples (37-39,44-46).

A high number of species of these zoosporic fungi are expected to be found in soil samples of the Atlantic Rainforest, due to the high moisture content (43). The diversity of zoosporic fungi reported for the region of Cubatão, as expressed by the occurrence of 66 taxa, may be considered high in comparison to the earlier studies in the Atlantic Rainforest, mentioned above. On the other hand, there is still little information on the occurrence of these fungi in polluted sites (8,65), mainly in Brazil (43,49).

Among the mucoraceous fungi isolated, 40 taxa were isolated from leaf litter and soil samples (Table 2). *Mucor amphibiorum* Schipper, *Mucor pravagensis* Mehrotra & Nand ex Schipper, *Parasitella parasitica* (Bain.) Syd and *Rhopalomyces* sp. are reported for the first time in Brazil.

The diversity of Mucorales reported in this study may also be considered high, when compared to former studies in other areas of the Atlantic Rainforest. In the "Parque Estadual das Fontes do Ipiranga", in the municipality of São Paulo, a study of the diversity of Mucorales in soil samples, during eleven months, resulted in the identification of 21 taxa (73) and a survey conducted in the "Reserva Biológica de Paranapiacaba" yielded 13 species of Mucorales (55). The highest number of Mucorales taxa was obtained from the soil followed by the leaf litter (Table 2). The affinities of the species of Mucorales to disturbed environments are well documented in the literature. For instance, among several species of Mucorales, some such as *Rhizopus sexualis*, *Rhizopus stolonifer* and *Mortierella ramanniana* have been studied concerning their ability to retain heavy metals (3).

From the soil samples, a total of 44 taxa of Glomales (AMF- arbuscular mycorrhizal fungi) were obtained (Table 3). All reported taxa have already been mentioned in earlier surveys in the Brazilian Atlantic Rainforest, especially in the "Reserva Biológica de Paranapiacaba", in association with Melastomataceae and other native plants, resulting in the isolation of 23 to 26 Glomales taxa (69). In the Atlantic Rainforest of "Ilha do Cardoso" higher numbers of taxa, from 35 to 47, were observed during three years of intensive survey in forest areas (66,67) and about 14 to 24 taxa of Glomales in native vegetation of dunes (71,72).

In the "Parque Estadual das Fontes do Ipiranga" 20 taxa of Glomales were observed on ornamental plants (70), and 10, especifically on Marantaceae (24). Nineteen taxa were reported during a study on morphological aspects of native plants and the diversity of Glomales in the Atlantic Rainforest in the municipality of Cubatão (33) and 21 taxa of Glomales were observed in the soil of the "Ilha dos Eucaliptos" in the municipality of São Paulo (14).

The anamorphs were represented by the occurrence of 125 taxa, six atypical strains of *Fusarium* and seven non-sporulating fungi, with high predominance on leaf litter (Table 4). *Acrodyctis erecta*

Table 2. Mucorales present (+) in the soil and mixed leaf litter in the region of Cubatão. Legend: ◆ new record for Brazil.

MUCORALES	Soil	Leaf litter
Absidia repens van Tieghem	+	-
Backusella lamprospora (Lendner) Ellis & Hesseltine	-	+
Circinella simplex van Tieghem	+	-
Cunninghamella blakesleeana Lendner	+	+
C. echinulata (Thaxter) Thaxter	+	+
C. elegans Lendner	+	-
C. polymorpha Pispek	+	-
Mucor amphibiorum Schipper ◆	+	-
M. circinelloides van Tieghem f. *circinelloides* van Tieghem	+	-
M. circinelloides van Tieghem f. *griseo- cyanus* (Hagem) Schipper	+	+
M. circinelloides van Tieghem f. *janssenii* (Lendner) Schipper	+	+
M. genevensis Lendner	+	-
M. hiemalis Wehmer f. *corticolus* (Hagem) Schipper	+	+
M. hiemalis Wehmer f. *hiemalis* Wehmer	+	+
M. hiemalis Wehmer f. *luteus* (Linnemann) Schipper	+	+
M. hiemalis Wehmer f. *silvaticus* (Hagem) Schipper	+	+
M. microsporus Namyslowski	+	-
M. minutus (Baijal & Mehrotra) Schipper	+	-
M. mousanensis Baijal & Mehrotra	+	-
M. piriformis Fischer	+	-
M. prayagensis Mehrotra & Nand ex Schipper ◆	+	-
M. racemosus Fres. f. *chibinenis* (Neophytova) Schipper	+	-
M. racemosus Fres. f. *racemosus* Fres.	+	+
M. racemosus Fres. f. *sphaerosporus* (Hagem) Schipper	+	-
M. ramosissimus Samutsevitsch	+	+
M. saturninus Hagem	+	+
M. sinensis Milko & Belyakova	+	+
M. subtilissimus Oudemans	+	+
M. variabilis Sarbhoy	-	+
M. variosporus Schipper	+	+
M. zonatus Milko	+	+
Parasitella parasitica (Bain.) Syd. ◆	+	-
Poitrasia circinans Bainier	+	+
Rhizomucor pusillus (Lindt) Schipper	+	-
Rhizopus oligosporus Saito	-	+
R. oryzae Went & Prinsen Geerlings	+	-
R. stolonifer Ehrenberg	+	+
Rhopalomyces sp.◆	-	+
Zygorhynchus heterogamus (Vuill.) Vuill.	+	-
Z. moelleri Vuill.	+	-
Total number of taxa	36	21

Table 3. Glomales present (+) in the soil in the region of Cubatão.

Acaulospora appendicula Spain, Siev. & Schenck
A. cavernata Blaskowsky
A. delicata Walker, Pfeiffer & Bloss
A. foveata Trappe & Janos
A. longula Spain & Schenck
A. mellea Spain & Schenck
A. morrowiae Spain & Schenck
A. rehmii Sieverding & Toro
A. rugosa Morton
A. scrobiculata Trappe
A. tuberculata Janos & Trappe
Acaulospora spp.
Entrophospora infrequens (Hall) Ames & Schneider
E. kentinensis Wu & Liu
Gigaspora ramisporophora Spain, Siev. & Schenck
Glomus sp.
Glomus aggregatum Schenck & Smith emend. Walker
G. albidum Walker & Rhodes
G. claroideum Schenck & Smith
G. clarum Nicol. & Schenck
G. clavisporum (Trappe) Almeida & Schenck
G. constrictum Trappe
G. diaphanum Norton & Walker
G. etunicatum Becker & Gerdermann
G. fasciculatum (Thaxter) Gerd. & Trappe emend. Walker
G. fistulosum Skou & Jacobsen
G. geosporum (Nicolson & Gerdermann) Walker
G. globiferum Koske & Walker
G. invermayum Hall
G. lamellosum Dalpé, Koske & Tews
G. macrocarpum Tul. & Tul.
G. magnicaule Hall
G. microcarpum Tul. & Tul.
G. mosseae Nicolson & Gerdermann
G. multisubstensum Mukerji, Battacharjee & Tewari
G. occultum Walker
G. sinuosum (Ged. & Bakshi) Almeida & Schenck
G. tenebrosum (Thaxter) Berch
Scutellospora erythropa (Koske & Walker) Walker & Sanders
S. gilmorei (Trappe & Gerd.) Walker & Sanders
S. heterogama (Nicol. & Gerd.) Walker & Sanders
S. nigra (Redhead) Walker & Sanders
S. pellucida (Nicolson & Gerdermann) Walker & Sanders
S. persica (Ksoake & Walker) Walker & Sanders
S. weresubiae Koske & Walker
Total of taxa: 45

(Ellis & Everh.) M.B. Ellis, *Ceratosporella deviata* Subram., *Dendryphion comosum* Wallr., *Graphium* cf. c*alicioides* (Fr.) Cooke & Massee, *Gyrothrix ramosa* Zucconi & Onofri, *Mycoleptodiscus disciformis* Matsush., *Periconia ignaria* Booth, *Polyschema olivaceae* (Ellis & Everth.) M.B. Ellis and *Vermiculariopsiella cubensis* (R. F. Castañeda) Nawawi Kuthub. & B. Sutton are reported for the first time for Brazil.

The diversity of the anamorphs is influenced by the technique used to isolate the microorganisms associated to decomposing leaf litter and this was observed in the present study. Only *Alternaria alternata* and *Pestalotiopsis* sp. were isolated by the moist chamber technique and incubation on culture media.

Only a few representants of Ascomycota and Basidiomycota were observed in this study, probably due the isolation methods employed.

In the Atlantic Rainforest of São Paulo State, many surveys of anamorphs, using moist chamber incubation, have been published, such as the ones conducted in the "Parque Estadual das Fontes do Ipiranga", an urban forest, reporting 23 Hyphomycetes obtained from roots of the Marantaceae plants *Calathea stromata* (15), *Maranta bicolor* Ker. (16), *Ctenanthe oppenheimiana* Sond. (17) and *Stromanthe sanguinea* Sond. (18). Grandi (71) listed 41 taxa of dematiaceous fungi isolated by the serial washing technique from the sites studied in this work, and concluded that the majority of them presented little substrate specifity and were of wide distribution or even cosmopolitan.

In the Atlantic Rainforest of the "Reserva Biológica de Paranapiacaba" 11 Hyphomycetes were reported for the roots of *Calathea zebrina* (Sims) Lindl., 23 for leaf litter of *Alchornea triplinervia* (Spreng.) M. Arg. (19) and 10 for *Euterpe edulis* Mart. (20). Gusmão *et al.* (25) isolated 55 Hyphomycetes associated with living and decomposing leaves of *Miconia cabussu* Hoehne in the same reserve.

In the preserved areas of the "Estação Ecológica da Juréia-Itatins", 55 anamorphs were isolated from the soil and screened for cellulolytic enzymes (2), 16 taxa associated to leaf litter of *Alchornea triplinervia* (22) and 76 taxa composed a part of the mycota in the aquatic and terrestrial environments (42).

Ecological studies about leaf litter decomposition, fungal succession and evaluation of the effect of several impacts on the diversity of terrestrial or aquatic fungi have contributed to enhance the knowledge about the diversity of the native mycota in the Atlantic Rainforest in the State of São Paulo. For instance, the study of the fungal succession on leaves of *Ficus microcarpa* L.f., submerged in a lake in the "Parque Estadual das Fontes do Ipiranga" resulted in the identification of eight zoosporic fungi, 20 anamorphs and two Mucorales (54). In the same area, an evaluation of diversity of a soil submitted to high quantities of bird's excrements yielded seven zoosporic fungi, 22 anamorphs, 19 Mucorales and one Ascomycota (41,60).

Table 4. Anamorphs, Ascomycota and Basidiomycota present (+) in the soil and mixed leaf litter in the region of Cubatão. Legend: ◆ new record for Brazil; * Isolated only by moist chamber technique.

ANAMORPHS FUNGI	Soil	Leaf litter
Acremonium strictum W. Gams	+	+
Acremonium sp	-	+
A. terricola (Miller & al.) W. Gams	-	+
Acrodyctis erecta (Ellis & Everh.) M.B. Ellis* ◆	-	+
Alternaria alternata (Fr.) Keissler	-	+
Aspergillus alutaceus Berk. & Curt.	+	-
A. carbonarius (Bain.) Thom	+	-
A. cervinus (Massee) Neill	-	+
A. clavatus Desmazieres	+	+
A. clavatus v. gigantea Blochwitz	+	-
A. flavus Link	+	+
A. fumigatus Fresenius	+	+
A. niger van Tieghem	+	+
A. variecolor Berkeley & Broome	+	+
A. versicolor Tiraboschi	+	-
A. zonatus Kwen & Fennell	+	-
Beltrania rhombica Penzig	-	+
Beltraniella portoricensis (F.L. Stevens) Pirozynski & Patil)*	-	+
Beltraniella sp.	-	+
Beltraniopsis ramosa Castañeda Ruiz*	-	+
Bipolaris sp.	-	+
Camposporium antennatum Harkness.*	-	+
Ceratosporella deviata Subram.* ◆	-	+
Chalara alabamensis Morgan-Jones & Ingram*	-	+
Cladosporium cladosporioides (Fresen.) de Vries	+	+
C. oxysporum Berk. & Curt.	+	+
C. sphaerospermum Penzig	+	+
Colletotrichum gloeosporioides (Penz.) Sacc.	+	+
C. orbiculare (Berk. & Mont.) Arx	-	+
Cryptophiale udagawae Pirozynski*	-	+
Curvularia brachyspora Boedijn	-	+
C. eragrostidis (P. Henn.) J. A Meyer*	-	+
C. lunata (Wakker) Boedijn	-	+
C. pallescens Boedijn	-	+
C. trifolii (Kauffm.) Boedijn	-	+
Cylindrocladiella parvum P.J. Anderson	-	+
C. scoparium Morgan	-	+
Dendryphion comosum Wallr.* ◆	-	+
Dictyochaeta simplex (Hughes & Kendrick) Hol.-Jech.*	-	+
Diplococcium sp.	-	+
Drechslera dematioidea (Bubák & Wróblewski)	-	+
D. ravenelli (Curt.) Subram. & Jain	-	+
Epicoccum nigrum Link	-	+
Fusarium chlamydosporum Wollenw. & Reinking	+	-
F. moniliforme Sheldon	+	-
F. oxysporum Schlecht. Emend Snyd. & Hans.	+	+
F. sambucinum Fuckel	+	+
F. solani (Mart.) Appel & Wollenw. Emend Snyd & Hans.	+	+
F. lateritium Nees	-	+
Fusarium spp. (6 atipical strains)	+	+
Geotrichum candidum Link & Leman	+	-
Gliocladium roseum Bainier	-	+
Graphium cf. calicioides (Fr.) Cooke & Massee* ◆	-	+
Gyrothrix circinata (Berk. & Curt.) Hughes*	-	+
Gyrothrix cf. *microsperma* (Hoehnel) Pirozinsky*	-	+
Gyrothrix podosperma (Corda) Rabenhorst*	-	+
G. ramosa Zucconi & Onofri* ◆	-	+
Humicola fuscoatra Traaen	+	+
H. grisea Traaen*	-	+
Humicola sp.	-	+
Kionochaeta ramifera (Matsushima) P.M. Kirk & Sutton*	-	+
Memnoniella echinata (Riv.) Galloway*	-	+
Menisporopsis theobromae Hughes*	-	+
Menisporosis spp.*	-	+
Mycoleptodiscus disciformis Matush.* ◆	-	+
Nakataea fusispora (Matsushima) Matsushima*	-	+
Nigrospora oryzae (Berk. & Br.) Petch	-	+
Nigrospora sphaerica (Sacc.) Mason	-	+
Paecilomyces javanicus (Friederichs & Bally) Brown & Smith	-	+
P. lilacinus (Thom) Samson	+	-
P. variotii Bainier		+
Penicillium aurantiogriseum Dierckx	-	+
P. canescens Sopp	-	+
P. citreonigrum Dierckx	+	-
P. citrinum Thom	+	-
P. decumbens Thom	-	+
P. fellutanum Biourge	-	+
P. glabrum (Wehmer) Westling	-	+
P. griseofulvum Dierckx	+	-
P. implicatum Biourge	-	+
P. janthinellum Biourge	+	-
P. miczynskii Zaleski	+	-
P. oxalicum Currie & Thom	+	-
P. purpurogenum Stoll	+	+
P. raistrickii G. Smith	+	+
P. restrictum Gilman & Abbott	-	+
P. rugulosum Thom	-	+
P. simplicissimum (Oudem.) Thom	+	-
P. echinulatum Raper & Thom ex Fassatiová	-	+
P. thomii Maire	+	+
P. verrucosum Dierckx	-	+
Penicillium viridicatum Westling	+	-
Periconia atropurpurea (Berk. & Curt.) Litvinov	-	+
P. byssoides Pers. ex Mérat	-	+
P. echinochloae (Batista) M.B. Ellis	-	+
P. igniaria Booth* ◆	-	+
Pestalotia sp.	-	+
Pestalotiopsis spp.	+	+
Phaeoisaria clematidis (Fuckel) Hughes*	-	+
Phoma jolyana Pirozynski & Morgan-Jones	+	-
P. tropica Schneider & Boerema	+	+
Pithomyces chartarum (Berk. & Curt.) M.B. Ellis*	-	+

	Soil	Leaf litter
P. maydicus (Sacc.) M.B. Ellis*	-	+
Polyschema olivacea (Ellis & Everth.) M.B. Ellis*◆	-	+
Pseudotracylla sp.*	-	+
Sporidesmiella hyalosperma (Corda) P.M. Kirk v. *hyalosperma**	-	+
Subulispora longirostrata Nawawi & Kuthubutheen*	-	+
Subulispora procurvata Tubaki*	-	+
Tetraploa aristata Berk. & Br.*	-	+
Thozetella cristata Pirozynki & Hodges*	-	+
Thozetella cubensis Castañeda Ruiz & Arnold*	-	+
Trichoderma aureoviride Rifai	-	-
T. hamatum (Bonord.) Bain.	+	+
T. harzianum Rifai	+	+
T. longibrachiatum Rifai	+	-
T. polysporum (Link ex Pers.) Rifai	-	+
T. pseudokoningii Rifai	+	+
T. viride Pers: Fr.	+	+
Venustusynnema sp.*	-	+
Vermiculariopsiella cubensis (R.F. Castañeda) Nawawi, Kuthub. & B. Sutton *◆	-	+
Veronae apiculata (Miller, Giddens & Foster) M.B. Ellis	-	+
Verticillium lecanii (Zimm.) Viegas	+	+
V. luteo-album Link	-	+
Wiesneromyces laurinus (Tassi) P.M. Kirk*	-	+
Zygosporium sp.	-	+
Total number of taxa of anamorphic fungi	44	105
Ascomycota		
Eupenicillium sp.	-	+
Nectria haematococca Berk. & Br.	-	+
Neurospora crassa Shear & Dodge	-	+
Total of taxa of Ascomycota	0	3
Basidiomycota		
Pycnoporus sanguineus *(L.:Fr.) Murr.*	-	+
Total of taxa of Basidiomycota	0	1

In the preserved forest of the “Reserva Biológica de Paranapiacaba” the study of the fungal succession on *Alchornea triplinervia* leaves in the terrestrial and aquatic environments resulted in the isolation of 20 zoosporic fungi, 82 anamorphs, 20 Mucorales and eight Ascomycota, a total of 123 fungal taxa (55-58). Comparison of the aquatic mycota on submerged leaves of *Ficus microcarpa* L. f., *Quercus robur* L. and *Alchornea triplinervia* in a same stream, permitted the observation of 20 zoosporic fungi and 11 aquatic Hyphomycetes (59).

In the municipality of São Paulo, studies in the reservoir “Represa do Guarapiranga” contributed to the knowledge about the fungal diversity in urban sites, by the isolation of 28 zoosporic fungi (50), 71 anamorphs, 7 Mucorales and four Ascomycota (32). Especifically in the island “Ilha dos Eucaliptos”, the evaluation of the vegetation replacement on the terrestrial mycota yielded 53 anamorphs, 12 Mucorales and three Ascomycota (51,75).

Based on earlier surveys in the Atlantic Rainforest of São Paulo State mentioned above, the number of fungal species of zoosporic fungi, Mucorales, Glomales and anamorphs in the soil, water and mixed leaf litter may be considered still high, despite possible reflexes of the environmental restrictions of the sites studied.

ACKNOWLEDGEMENTS

The authors are grateful to CNPq and FAPESP for financial support.

RESUMO

Fungos microscópicos de Mata Atlântica em Cubatão, São Paulo, Brasil

Este artigo apresenta o levantamento dos fungos obtidos de amostras de solo, água e folhedo mixto coletados da Mata Atlântica no município de Cubatão, estado de São Paulo, durante os anos de 1993 a 1995. Utilizando diferentes técnicas para isolamento de fungos microscópicos, um total de 280 táxons foram obtidos (66 fungos zoospóricos, 40 representantes de Mucorales, 45 de Glomales, 125 fungos anamorfos, três de Ascomycota e um representante de Basidiomycota), sendo 23 espécies reportadas pela primeira vez para o Brasil.

Palavras-chave: fungos microscópicos, diversidade, Mata Atlântica, Brasil.

REFERENCES

1. Antunes, M.F.; Ninomiya, A.; Schoenlein-Crusius, I.H. Efeitos da queimada sobre a micota de solo situado na mata atlântica, na Reserva Biológica do Alto da Serra de Paranapiacaba, SP. *Hoehnea*, 20, 1-8, 1993.
2. Attili, D.S. *Isolamento, identificação e ecologia de fungos celulolíticos do solo da Estação Ecológica de Juréia-Itatins, SP*. Rio Claro, São Paulo, 1994, 148p. (PhD. Thesis. Instituto de Biociências. UNESP).
3. Azab, M.S.; Peterson, P.J.; Young, T.W.K. Uptake of cadmium by fungal biomass. *Microbios*, 62, 23-28, 1990.
4. Barnett, H.L.; Hunter, B.B. *Illustrated genera of Imperfect Fungi*, 4th ed., APS Press, Saint Paul, Minneapolis, 1998.
5. Barron, G.L. *The genera of Hyphomycetes from soil*. Robert Krieger, New York, 1968.
6. Beneke, E.S.; Rogers, A.L. Aquatic Phycomycetes from the states of São Paulo, Minas Gerais and Paraná, Brazil. *Rickia*, 1, 181-193, 1962.
7. Carvalho, Y.; Milanez, A.I. Efeitos do pH e temperatura sobre *Pythium splendens* Braun *in vitro*. *Rev. Bras. Bot.*, 11, 33-36, 1988.

8. Cooke, W.B. Fungi in sewage. *In*: Jones, G. (Ed.). *Recent Advances in Aquatic Mycology*. Elek Science, London, 1976.
9. Domsch, K.H.; Gams, W.; Anderson, T.H. *Compendium of soil fungi.* Academic Press, New York, 1980.
10. Ellis, M.B. *Dematiaceous Hyphomycetes*. Commonwealth Mycological Institute, Kew, 1971.
11. Ellis, M.B. *More Dematiaceous Hyphomycetes*. Commonwealth Mycological Institute, Kew, 1976.
12. Garlipp, A.B. *Isolamento e identificação de fungos filamentosos do solo do banhado grande na Estação Ecológica de Juréia-Itatins, SP*. Rio Claro, 1995, 92p. (MSc. Thesis. Instituto de Biociências. UNESP).
13. Gerdemann, J.H.; Nicolson, T.H. Spores of mycorrhizal Endogone species extracted from soil by wet sieving and decanting. *Trans. Brit mycol. Soc.*, 46, 234-244, 1963.
14. Gomes, S.P.; Trufem, S.F.B. Fungos micorrízicos arbusculares (Glomales, Zygomycota) na Ilha dos Eucaliptos, Represa do Guarapiranga, São Paulo, SP. *Acta Bot. Bras.*, 12, 393-401, 1998.
15. Grandi, R.A.P. Hyphomycetes decompositores 1. Espécies associadas às raízes de *Calathea stromata* (horticultural). *Rev. Bras. Biol.*, 50, 123-132, 1990.
16. Grandi, R.A.P. Hyphomycetes decompositores 2. Táxons associados às raízes de *Maranta bicolor* Ker. *Rev. Bras. Biol.*, 51, 133-141, 1991a.
17. Grandi, R.A.P. Hyphomycetes decompositores 4. Espécies associadas às raízes de *Ctenanthe oppenheimiana* Sond. *Acta Bot. Bras.*, 5, 13-23, 1991b.
18. Grandi, R.A.P. Hyphomycetes decompositores 3. Espécies associadas às raízes de *Stromanthe sanguinea* Sond. *Rev. Bras. Biol.*, 52, 275-282, 1992.
19. Grandi, R.A.P. Hyphomycetes decompositores do folhedo de *Alchornea triplinervia* (Spreng.) Muell. Arg. *Hoehnea*, 25, 133-148, 1998.
20. Grandi, R.A.P. Hifomicetos decompositores do folhedo de *Euterpe edulis* Mart. *Hoehnea*, 26, 87-101, 1999.
21. Grandi, R.A.P. Anamorfos da serapilheira nos Vales dos Rios Moji e Pilões, município de Cubatão, São Paulo, Brasil. *Hoehnea*, 31, 225-238, 2004.
22. Grandi, R.A.P.; Attili, D.S. Hyphomycetes on *Alchornea triplinervia* (Spreng.) Muell. Arg. leaf litter from the Ecological Reserve Juréia-Itatins, State of São Paulo, Brazil. *Mycotaxon*, 60, 373-386, 1996.
23. Grandi, R.A.P.; Gusmão, L.F.P. Hyphomycetes decompositores de raízes de *Calathea zebrina* (Sims) Lindl. (Marantaceae), provenientes da Reserva Biológica do Alto da Serra de Paranapiacaba, Santo André, SP, Brasil. *Rev. Bras. Bot.*, 19, 165-172, 1996.
24. Grandi, R.A.P.; Trufem, S.F.B. Fungos micorrízicos vesículo-arbusculares em Marantaceae cultivadas no Instituto de Botânica, São Paulo. *Rev. Bras. Bot.*, 14, 89-95, 1991.
25. Gusmão, L.F.P.; Grandi, R.A.P.; Milanez, A.I. Hyphomycetes from leaf litter of *Miconia cabussu* in the Brazilian Atlantic Rain forest. *Mycotaxon*, 79, 201-213, 2001.
26. Harley, J.L.; Waid, J.S. A method of studying active mycelia on living roots and other surfaces in the soil. *Trans. Brit. Mycol. Soc.*, 38, 104-118, 1955.
27. Hesseltine, C.W.; Anderson, R.F. Microbiological production of carotenoids. I. Zygospores and carotene by intraespecific and interspecific crosses of *Choanephora* in liquid media. *Mycologia*, 69, 449-452, 1955.
28. Johnson Jr., T.W. *The genus Achlya: morphology and taxonomy*. Ann Arbor: University of Michigan Press, 1956.
29. Karling, J.S. *Chytridiomycetarum Iconographia*. J. Cramer, Vaduz, 1977.
30. Klumpp, A.; Domingos, M.; Klumpp, G. Assessment of the vegetation risk by fluoride emissions from fertiliser industries at Cubatão, Brazil. *Sci. Total Environ.*, 192, 219-228, 1996.
31. Klumpp, G.; Furlan, C.M.; Domingos, M.; Klumpp, A. Response of stress indicators and growth parameters of *Tibouchina pulchra* Cogn. exposed to air and soil pollution near the industrial complex of Cubatão, Brazil. *Sci. Total Environ.*, 246, 79-91, 2000.
32. Malosso, E. *Hyphomycetes em ambientes aquáticos lótico e lêntico - ocorrência e biomassa*. São Carlos, 1999, 98p. (MSc. Thesis. Instituto de Ciências Biológicas. UFSCAR).
33. Mazzoni-Viveiros, S.C. *Aspectos estruturais de Tibouchina pulchra Cogn. (Melastomataceae) sob o impacto de poluentes atmosféricos provenientes do complexo industrial de Cubatão, SP, Brasil*. *Rev. Bras. Bot.*, 27, 337-348. 2004.
34. Mercado Sierra, A.; Holubová-Jechová, V.; Mena Portales, J. *Hifomicetes demaciáceos de Cuba - Enteroblásticos*. Museo Regionale di Scienze Naturali, Torina, 1997.
35. Milanez, A.I. Fungos de águas continentais. *In*: Fidalgo, O.; Bononi, V.L.R. (Eds.).*Técnicas de coleta, preservação e herborização de material botânico*. Instituto de Botânica, São Paulo, Brazil, 1989.
36. Milanez, A.I.; Trufem, S.F.B. Fungos zoospóricos em frutos submersos do Parque Estadual das Fontes do Ipiranga, São Paulo, 2. *Rickia* 11, 77-84, 1984.
37. Milanez, A.I.; Pires-Zottarelli, C.L.A.; Schoenlein-Crusius, I.H. Criptógamos do Parque Estadual das Fontes do Ipiranga, Fungos 1: Monoblepharidales. *Hoehnea*, 21, 157-161, 1994.
38. Milanez, A.I.; Pires-Zottarelli, C.L.A.; Schoenlein-Crusius, I.H. Criptógamos do Parque Estadual das Fontes do Ipiranga. São Paulo, SP. Fungos 2: Lagenidiales. *Hoehnea*, 22, 115-123, 1995.
39. Milanez, A.I.; Pires-Zottarelli, C.L.A.; Schoenlein-Crusius, I.H. Criptógamos do Parque Estadual das Fontes do Ipiranga, Fungos 5: Leptomitales (Rhipidiaceae). *Hoehnea*, 23, 67-76, 1996.
40. Milanez, A.I.; Pires-Zottarelli, C.L.A.; Schoenlein-Crusius, I.H.; Lohmann, L. Criptóghamos do Parque Estadual das Fontes do Ipiranga, São Paulo, SP. Blastocladiales. *Hoehnea*, 30, 21-29. 2003.
41. Ninomiya, A.; Antunes, M.F.R.; Schoenlein-Crusius, I.H. Fungi from soil affected by birds in the "Parque Estadual das Fontes do Ipiranga", São Paulo State, Brazil. *Rev. Microbiol.*, 24, 149-151, 1993.
42. Pinto, I.M.A. *As micotas filamentosas do solo e da água do Rio Una do Prelado, Estação Ecológica de Juréia Itatins, SP*. Rio Claro, SP, 1999 , 186p. (PHD. Thesis. Instituto de Biociências. UNESP).
43. Pires-Zottarelli, C.L.A. *Fungos zoospóricos dos vales dos rios Moji e Pilões, região de Cubatão, SP.* Rio Claro, SP, 1999, 300p. (PhD. Thesis. Instituto de Biociências. UNESP).
44. Pires-Zottarelli, C.L.A.; Milanez, A.I.; Schoenlein-Crusius, I.H.; Lohmann, L.G. Criptógamos do Parque Estadual das Fontes do Ipiranga, São Paulo, SP. Fungos, 3: Peronosporales (Pythiaceae). *Hoehnea*, 22, 125-133, 1995.
45. Pires-Zottarelli, C.L.A.; Milanez, A.I.; Schoenlein-Crusius, I.H.; Lohmann, L.G. Criptógamos do Parque Estadual das Fontes do Ipiranga, São Paulo, SP. Fungos, 4: Saprolegniales. *Hoehnea*, 23, 39-66, 1996 a.
46. Pires-Zottarelli, C.L.A.; Milanez, A.I.; Schoenlein-Crusius, I.H.; Lohmann, L.G. Criptógamos do Parque Estadual das Fontes do Ipiranga, São Paulo, SP. Fungos, 6: Chytridiales. *Hoehnea*, 23, 77-90, 1996b.
47. Plaats-Niterink, A.J. Monograph of genus *Pythium*. *Studies in Mycology*, 21, 1-242, 1981.
48. Pugh, G.J.F.; Buckey, N.G.; Mulder, J. The role of phylloplane fungi in the early colonization of leaves. *Symp. Biol. Hung.*, 11, 329-333, 1972.
49. Rocha, M. *Micota zoospórica de lagos com diferentes trofias do parque Estadual das Fontes do Ipiranga (PEFI), São Paulo, SP*. São Paulo, 2004, 85p. (MSc. Thesis. Instituto de Ciências Biomédicas. USP).
50. Rocha, M.; Pires-Zottarelli, C.L.A. Chytridiomycota e Oomycota da Represa do Guarapiranga, São Paulo, SP. *Acta Bot. Bras*., 16, 287-309, 2002.

51. Santos, V.B.; Wellbaum, C.; Schoenlein-Crusius, I.H. Fungos filamentosos do solo da Ilha dos Eucaliptos na Represa do Guarapiranga, município de São Paulo, SP. *Acta Bot. Bras.*, 12, 101-110, 1998.
52. Schenck, N.C. *Methods and principles of mycorrhizal research*. American Phytopathological Society, St. Paul, USA, 1982.
53. Schipper, M.A.A. A study on variability in *Mucor hiemalis* and related species. *Studies in Mycology*, 4, 1-29, 1975.
54. Schoenlein-Crusius, I.H.; Milanez, A.I. Sucessão fúngica em folhas de *Ficus microcarpa* L. f. submersas no lago frontal situado no Parque Estadual das Fontes do Ipiranga, São Paulo, SP. *Rev. Microbiol.*, 20, 95-101, 1989.
55. Schoenlein-Crusius, I.H.; Milanez, A.I. Mucorales (Zygomycotina) da Mata Atlântica da reserva Biológica do Alto da Serra de Paranapiacaba, Santo André, SP. *Acta Bot. Bras.*, 11, 95-101, 1997.
56. Schoenlein-Crusius, I.H.; Milanez, A.I. Fungos microscópicos da Mata Atlântica de Paranapiacaba, São Paulo, Brasil. *Rev. Bras. Bot.*, 21, 73-79, 1998 a.
57. Schoenlein-Crusius, I.H.; Milanez, A.I. Fungal succession on leaves of *Alchornea triplinervia* (Spreng.) M. Arg. submerged in a stream of na Atlantic Rainforest in the state of São Paulo, Brazil. *Rev. Bras. Bot.*, 21, 253-259, 1998b.
58. Schoenlein-Crusius, I.H.; Milanez, A.I. Fungos zoospóricos (Mastigomycotina) da mata atlântica da Reserva Biológica do Alto da Serra de Paranapiacaba, município de Santo André, SP. *Rev. Bras. Bot.*, 21, 177-181, 1998c.
59. Schoenlein-Crusius, I.H.; Pires-Zottarelli, C.L.A.; Milanez, A.I.; Humphreys, R.D. Aquatic fungi in leaves submerged in a stream in the atlantic rainforest. *Rev. Microbiol.*, 23, 167-171, 1992.
60. Schoenlein-Crusius, I.H.; Trufem, S.F.B.; Malatinsky, S.M.M.; Ninomiya, A.; Antunes, M.F.R. Mucorales (Zygomycotina) from soil affected by excrement of birds in the Parque Estadual das Fontes do Ipiranga, São Paulo, Brazil. *Rev. Bras. Bot.*, 19, 7-10, 1996.
61. Schoenlein-Crusius, I.H.; Trufem, S.F.B.; Grandi, R.A.P.; Milanez, A.I.; Pires-Zottarelli, C.L.A. Airborne fungi in the region of Cubatão, São Paulo state, Brazil. *Braz. J. Microbiol.*, 32, 61-65, 2001.
62. Scott, W.W. A revision of the genus *Aphanomyces. Technical Bulletin Virginia Agricultural Experiment Station*, 151, 1-95, 1961.
63. Seymour, R.L. The genus *Saprolegnia*. *Nova Hedwigia* 19(½), 1-124, 1970.
64. Sparrow Jr., F.K. *Aquatic Phycomycetes*. University of Michigan Press. 2ª ed. Ann Arbor, 1960.
65. Steciow, M.M. Variación estacional de los Oomycetes en un ambiente contaminado: Rio Santiago y afluentes (Buenos Ayres, Argentina). *Rev. Iberoam. Micol.*, 15, 0-43, 1998.
66. Trufem, S.F.B. Aspectos ecológicos de fungos micorrízicos vesículo-arbusculares em rizosferas de plantas de mata tropical úmida da Ilha do Cardoso, SP, Brasil. *Acta Bot. Bras.*, 4, 31-45, 1990 a.
67. Trufem, S.F.B. Aspectos ecológicos de fungos micorrízicos vesículo arbusculares de ecossistema de dunas do Parque Estadual da Ilha do Cardoso, SP, Brasil. Anais do II Simpósio sobre Ecossistemas da Costa Sul e Sudeste do Brasil. ACIESP, São Paulo, Brazil, 1990 b.
68. Trufem, S.F.B. Fungos micorrízicos arbusculares em plantas de restinga da Ilha do Cardoso, SP, Brasil. *Rev. Bras. Bot.*, 18, 51-60, 1995.
69. Trufem, S.F.B.; Malatisnky, S.M.M. Fungos micorrízicos arbusculares em Melastomataceae e outras plantas resistentes e sensíveis à poluição na reserva Biológica do Alto da Serra de Paranapiacaba, SP, Brasil. *Hoehnea*, 22, 7-89, 1995.
70. Trufem, S.F.B.; Grandi, R.A.P.; Silveira, R.B.A. Fungos micorrízicos vesículo-arbusculares em plantas ornamentais do Jardim Botânico. *Hoehnea*, 17, 85-89, 1990.
71. Trufem, S.F.B.; Otomo, H.S.; Malatinszky, S.M.M. Fungos micorrízicos vesículo-arbusculares em rizosferas de plantas de dunas do Parque Estadual da Ilha do Cardoso, SP, Brasil. 1. Taxonomia. *Acta Bot. Bras.*, 3, 141-152, 1989.
72. Trufem, S.F.B.; Otomo, H.S.; Malatinszky, S.M.M. Fungos micorrízicos arbusculares em rizosferas de plantas de duna do Parque Estadual da Ilha do Cardoso, SP, Brasil. 2. *Acta Bot. Bras.*, 8, 31-45, 1994.
73. Viriato, A. *Diversidade de Mucorales (Zygomycotina) em solo e em fezes de herbívoros no Parque Estadual das Fontes do Ipiranga, São Paulo, SP, Brasil*. Guarulhos, SP, 1996. (MSc. Thesis. Universidade de Guarulhos).
74. Warcup, J.H. The soil plate method for isolations of fungi from soil. *Nature*, 116, 117-118, 1950.
75. Wellbaum, C.; Schoenlein-Crusius, I.H.; Santos, V. Fungos filamentosos em folhas de ambiente terrestre e aquático da Ilha dos Eucaliptos, Represa de Guarapiranga, São Paulo, SP. *Rev. Bras. Bot.*, 22, 69-74, 1999.