

Fungal biodiversity in the air of Turin

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Abstract

The qualitative fungal composition of Turin's atmospheric environment was surveyed, carrying out a twelve-month study and collecting with a single stage volumetric sieve sampler on Dermasel agar supplemented with 0.4 g l^{-1} cycloheximide and 0.05 g l^{-1} chloramphenicol. We isolated 165 species and 2 varieties of mesophilic fungi from 58 genera and 26 thermotolerant species from 12 genera. *Penicillium*, *Aspergillus*, *Acremonium*, *Chrysosporium*, *Scopulariopsis*, *Malbranchea*, *Paecilomyces*, *Phialophora* and *Cladosporium* were in sequence the genera most rich in mesophilic species; *Aspergillus*, *Penicillium*, *Chrysosporium* and *Scopulariopsis* the most rich in thermotolerant species. Many of the species isolated are rarely or never recorded in the atmospheric environment. Cycloheximide can thus be said to select among airborne fungi, giving a characteristic picture.

Key words: Airborne fungi, *Acremonium*, *Chrysosporium*, Cycloheximide-resistant fungi, *Malbranchea*, *Scopulariopsis*.

Abbreviation: CH, Cycloheximide; cfu, colony forming unit

Introduction

Of the various methods used to sample the fungal aerosol, those most suitable for qualitative investigations allow the germination of propagules and the subsequent development of fructifying mycelia. Determination of the shape and size of conidia and spores, in fact, is generally not enough for accurate species identification, and observation of the reproductive structures and the way the conidia are formed is necessary. Direct capture of propagules by sedimentation or aspiration on an agar medium in a Petri dish is one of the most common methods, but is subject to the limitation that antagonism may prevent the development of weakly competitive species. This is particularly likely when the atmospheric concentrations are very high.

Cycloheximide (CH) is a well-known inhibitor of cytosol protein synthesis, and is used to isolate many pathogenic fungi from clinical specimens and the environment. A rather large number of such fungi, in fact, especially the filamentous ones, survive at the very high CH concentrations which inhibit the growth of numerous yeasts, saprotrophic fungi, plant pathogens and opportunistic pathogens [1–8]. This use of CH is

empirical and needs closer physiological and biochemical investigation, since it is not clear whether there is a close relation between CH tolerance and pathogenic potential, or whether the antibiotic is simply able to inhibit the development of many fast-growing fungi, and thus favour those with a low ability to compete as saprotrophs, such as the pathogenic and some potentially pathogenic species.

A preliminary study of airborne fungi in Turin has shown that whatever the reason for the differences in the way CH acts on fungi, its addition to the medium allows the capture of species that are not usually recorded, though it seems to greatly reduce the number of isolations [9]. We have therefore carried out a twelve-month study with CH in the medium to gain a better overall idea of the qualitative composition of Turin's atmospheric environment.

Materials and methods

Samples were taken at monthly intervals for a year, concurrently from two sites in Turin, at a height of about 2 m, between 10.00 h and 13.00 h, when light

intensity and most airborne fungi concentrations are highest [10]. However sampling during daytime is probably selective for some fungal propagules that peak exploiting the formation of dew. The collector was a single stage volumetric sieve sampler (Surface Air System, Pool Bioanalyse Italiana), powered by a 12 V rechargeable battery giving several hours of automatic operation. The model has a plate perforated by 220 holes and uses a 50 mm Rodac dish. The sampler was designed for microbiological sampling of air in confined spaces and on surfaces, but its level of efficiency for open air sampling is equivalent to that of an Andersen sampler [11]. Its aspiration rate is 180 l min⁻¹. During each sampling 12,000 l of air were aspirated and directed to 25 Petri dishes (480 l dish). Each dish was exposed for 160 seconds.

The collection medium was Dermasel Agar (Oxoid), supplemented with 0.4 g l⁻¹ cycloheximide and 0.05 g l⁻¹ chloramphenicol (Antibiotic Supplement SR 75, Oxoid). The dishes were incubated at 24 and 37 °C for isolation of mesophilic fungi (dishes 3–22) and thermotolerant ones (dishes 1, 2, 23–25) respectively.

After about 4–5 days, the dishes were read to identify and count the colonies. Sample colonies were then isolated in pure culture on media better adapted for verification of microscopic characteristics and species identification. The first reading was followed by others at weekly intervals, in order not to miss the counting and/or isolation of slowly growing elements. Yeasts were not identified.

Fungal load was evaluated as colony forming units (cfu) m⁻³ of air sampled.

The isolates are deposited in the culture collection belonging to the Dipartimento di Biologia vegetale dell'Università, viale P.A. Mattioli 25, 10125 Torino, Italy.

Results

We isolated 165 species and 2 varieties of mesophilic fungi from 58 genera (Table 1) and 26 thermotolerant species from 12 genera (Table 2).

All the thermotolerant species, except *Aspergillus alliaceus*, *Chrysosporium queenslandicum* and *Microascus cirrosus* were also isolated at 24 °C. The genera most rich in mesophilic species were *Penicillium* (31 species), *Aspergillus*, (18) *Acremonium* (12), *Chrysosporium* (11), *Scopulariopsis*, (9), *Malbranchea* (8), *Paecilomyces*, (6), *Phialophora* (5) and *Cladosporium* (5). The most rich in thermotolerant

ones were *Aspergillus* (9 species), *Penicillium* (4), *Chrysosporium* (3) and *Scopulariopsis* (2). Several genera were present with only one species (38 among mesophilic fungi and 8 among thermotolerant ones). *Mycelia sterilia moniliacea* and *dematiacea* could only be distinguished by the pigmentation of their hyphae, and probably belonged to different entities.

Tables 1 and 2 show the maximum, minimum and mean load of each species, and its frequency. Only three species - *Cladosporium cladosporioides*, *Penicillium brevicompactum* and *Aspergillus versicolor* - had load values of more than 10 cfu m⁻³ air. They were also present in 10 or more months of the year. The following mesophiles were present in at least 6 months (though with maximum load values of less than 5 cfu m⁻³): *Acremonium fusidoides*, *A. terricola*, *Alternaria alternata*, *Aphanocladium album*, *Aspergillus fumigatus*, *A. terricola*, *Beauveria bassiana*, *Chaetomium globosum*, *Chrysosporium carmichaelii*, *Cladosporium sphaerospermum*, *Geomyces pannorum* var. *pannorum*, *Malbranchea arcuata*, *M. pulchella*, *Mycelia sterilia dematiacea*, *Myrothecium roridum*, *Paecilomyces lilacinus*, *Penicillium jensenii*, *P. roquefortii*, *P. rugulosum*, *P. variable*, *P. waksmanii*, *Rhinocladiella pedrosoi*, *Scopulariopsis brevicaulis*, *S. brumptii*, *S. candida*, *S. crocii*, *S. koningii*, *S. sphaerospora*, *Stephanosporium cereale* and the yeasts. Only one thermotolerant *Aspergillus fumigatus* fell into this category.

These fungi could be considered the most characteristic of the CH-resistant airborne mycoflora. The remainder (83%) appear in less than 6 samplings and their maximum loads are usually less than 1 cfu m⁻³, apart from *Cladosporium chlorocephalum* (3.2 cfu m⁻³).

Discussion

The fungal biodiversity of Turin's air proved to be very great. Comparison of these results with those of other twelve-month or longer studies shows that we found more than twice [12–17] or even three or four times [18–30] as many genera or species. Similar findings have only been reported by Kramer et al. [31–33], Caretta et al. [34], Moustafa and Kamel [35] and Tseng and Chen [36]. These workers, however, took samples every day (or not less than three times a week) over periods of several hours and with a variety of collection media.

Table 1. Mesophilic species. Values in cfu m⁻³ air

		Load			F
		max	min	mean	
*	<i>Acremonium bactrocephalum</i> W. Gams	0.1	0.1	<0.1	2
	<i>charticola</i> (Lindau) W. Gams	0.1	0.1	<0.1	4
*	<i>curvulum</i> W. Gams	0.1	0.1	<0.1	1
*	<i>fusidioides</i> (Nicot) W. Gams	1.1	0.1	0.1	7
	<i>kiliense</i> Grütz	0.4	0.4	<0.1	1
*	<i>luzulae</i> (Fückel) W. Gams	0.1	0.1	<0.1	1
*	<i>murorum</i> (Corda) W. Gams	0.3	0.1	<0.1	3
*	<i>potronii</i> Vuill.	0.4	0.1	0.1	5
	<i>sclerotigenum</i> (F. & R. Morceau) W. Gams	0.2	0.2	<0.1	1
	<i>strictum</i> W. Gams	0.4	0.1	<0.1	5
	<i>terricola</i> (Miller et al.) W. Gams	0.4	0.1	<0.1	8
	<i>sp.</i>	0.1	0.1	<0.1	1
*	<i>Acrodontium crateriforme</i> (van Beyma) de Hoog	0.2	0.1	<0.1	2
	<i>Alternaria alternata</i> (Fr.) Keissler	2.1	0.1	0.4	10
*	<i>Aphanoascus fulvescens</i> (Cooke) Apinis	0.4	0.1	<0.1	2
	<i>Aphanocladium album</i> (Preuss) W. Gams	0.3	0.1	<0.1	7
*	<i>Arthrographis cuboidea</i> (Sacc. & Ellis) Sigler	0.1	0.1	<0.1	1
*	<i>Ascotricha bosei</i> D. Hawksw.	0.1	0.1	<0.1	1
	<i>Aspergillus amstelodami</i> Thom & Church	0.1	0.1	<0.1	1
	<i>chevalieri</i> (Mangin) Thom & Church v. <i>intermedius</i> Thom & Raper	0.2	0.1	<0.1	2
*	<i>deflectus</i> Fennel & Raper	0.1	0.1	<0.1	1
	<i>flavus</i> Link	0.2	0.1	<0.1	3
	<i>flavus</i> Link v. <i>columnaris</i> Fennel & Raper	0.3	0.1	<0.1	5
	<i>fumigatus</i> Fres.	0.6	0.1	0.6	10
	<i>melleus</i> Yukawa	0.1	0.1	<0.1	4
	<i>nidulans</i> (Eidam) Wint	0.3	0.3	<0.1	1
	<i>niger</i> van Tieghem	0.2	0.2	<0.1	1
	<i>ochraceus</i> Wilhelm	0.1	0.1	<0.1	3
	<i>oryzae</i> (Ahlb.) Cohn	0.1	0.1	<0.1	1
	<i>sclerotiorum</i> Huber	0.1	0.1	<0.1	3
*	<i>sulphureus</i> (Fres.) Thom & Church	0.4	0.1	<0.1	4
	<i>terreus</i> Thom	0.2	0.2	<0.1	1
*	<i>terricola</i> Marchall	0.3	0.1	<0.1	6
	<i>ustus</i> (Bain.) Thom & Church	0.4	0.1	<0.1	5
	<i>versicolor</i> (Vuill.) Tiraboschi	13.6	0.3	2.0	12
	<i>Beauveria bassiana</i> Vuill.	0.5	0.1	0.2	10
*	<i>brogniartii</i> (Sacc.) Petch	0.1	0.1	<0.1	1
	<i>Blastobotrys nivea</i> von Klopotek	0.1	0.1	<0.1	2
	<i>sp.</i>	0.1	0.1	<0.1	1
	<i>Chaetomium globosum</i> Kunze ex Fries	0.4	0.1	<0.1	6
*	<i>piluliferum</i> Daniels	0.1	0.1	<0.1	1
*	<i>Chalara st. Ceratocystis moniliformis</i> (Hedge.) C. Moreau	0.1	0.1	<0.1	1
	<i>Chrysosporium an. Arthroderma cuniculi</i> Dawson	0.1	0.1	<0.1	1
*	<i>an. Pectinotrichum llanense</i> Varsavsky & Orr	0.2	0.2	<0.1	1
*	<i>an. Renispora flavissima</i> Sigler et al.	0.1	0.1	<0.1	1
*	<i>carmichaelii</i> van Oorschot	0.5	0.1	<0.1	8
	<i>indicum</i> (Randhawa & Sandhu) Garg	0.2	0.1	<0.1	3
*	<i>keratinophilum</i> D. Frey ex Carmichael	0.1	0.1	<0.1	2
*	<i>sulfureum</i> (Fiedl.) van Oorschot & Samson	0.3	0.1	<0.1	4
*	<i>pannicola</i> (Corda) van Oorschot & Stalpers	0.1	0.1	<0.1	1
*	<i>pseudomerdarium</i> van Oorschot	0.1	0.1	<0.1	1
	<i>tropicum</i> Carmichael	0.2	0.1	<0.1	4
*	<i>xerophilum</i> Pitt	0.1	0.1	<0.1	1

Table 1. Continued

		Load			F
		max	min	mean	
*	<i>Cladobotryum varium</i> Nees ex Stendel	0.5	0.5	<0.1	1
*	<i>Cladosporium chlorocephalum</i> (Fresen) Mason & M. B. Ellis	3.2	0.1	0.2	4
	<i>cladosporioides</i> (Fresen.) de Vries	43.6	0.1	8.1	12
	<i>herbarum</i> (Pers.) Link ex Gray	0.1	0.1	<0.1	1
	<i>sphaerospermum</i> Penz	0.7	0.1	0.6	7
	<i>sp.</i>	0.1	0.1	<0.1	2
	<i>Coniothyrium sp.</i>	0.1	0.1	<0.1	1
*	<i>Cryptendoxyla hypophloia</i> Malloch & Cain	0.2	0.1	<0.1	5
*	<i>Dactylaria humicola</i> Bhatt & Kendrik <i>sensu</i> Knauss & Alfieri	0.1	0.1	<0.1	1
	<i>sp.</i>	0.4	0.1	<0.1	3
*	<i>Dicyma spinosa</i> (Emoto & Tubaki) von Arx	0.1	0.1	<0.1	1
*	<i>Doratomyces microsporus</i> (Sacc.) Morton & Smith	0.3	0.1	<0.1	4
	<i>purpureofuscus</i> (Fries) Morton & Smith	0.7	0.1	0.1	2
	<i>stemonitis</i> (Pers. ex Fr.) Morton & Smith	0.1	0.1	<0.1	1
*	<i>Engyodontium album</i> (Limber) de Hoog	0.2	0.1	<0.1	2
	<i>Geomyces pannorum</i> (Link) Sigler & Carmichael				
	<i>v. pannorum</i>	2.0	0.1	0.5	11
*	<i>v. asperulatus</i> (Sigler & Carmichael) van Oorschot	0.1	0.1	<0.1	1
	<i>Geotrichum candidum</i> Link	0.1	0.1	<0.1	1
*	<i>fermentans</i> (Diddens & Lodder) von Arx	0.1	0.1	<0.1	1
*	<i>Gongronella butleri</i> (Landner) Peyronel & Dal Vesco	0.1	0.1	<0.1	1
*	<i>Gymnoascus reessii</i> Baran.	0.1	0.1	<0.1	1
	<i>umbrinus</i> Boudier	0.1	0.1	<0.1	1
*	<i>Malbranchea arcuata</i> Sigler & Carmichael	0.9	0.1	<0.1	6
*	<i>chrysosporoidea</i> Sigler & Carmichael	0.2	0.1	<0.1	3
*	<i>flava</i> Sigler & Carmichael	0.1	0.1	<0.1	1
	<i>fulva</i> Sigler & Carmichael	0.2	0.1	<0.1	3
*	<i>gypsea</i> Sigler & Carmichael	0.2	0.1	<0.1	3
*	<i>pulchella</i> Saccardo & Penzig	0.3	0.1	<0.1	6
	<i>sulphurea</i> (Michel) Sigler & Carmichael	0.1	0.1	<0.1	1
*	<i>st. Uncinocarpus reesii</i> Sigler & Orr	0.2	0.1	<0.1	3
*	<i>Monocillium indicum</i> Saksena	0.1	0.1	<0.1	1
	<i>Mucor hiemalis</i> Wehmer	0.2	0.1	<0.1	2
	<i>Myceliophthora lutea</i> Cost	0.1	0.1	<0.1	2
	<i>vellerea</i> (Sacc. & Speg.) von Oorschot	0.1	0.1	<0.1	1
	<i>sp.</i>	0.1	0.1	<0.1	1
	<i>Mycelia sterilia dematiacea</i>	5.4	0.1	0.6	8
	<i>Mycelia sterilia moniliacea</i>	0.3	0.1	<0.1	4
	<i>Myriococcum sp.</i>	0.1	0.1	<0.1	1
	<i>Myrothecium roridum</i> Tode ex Fr.	0.3	0.1	<0.1	10
*	<i>Myxotrichum deflexum</i> Berkeley	0.8	0.1	<0.1	4
*	<i>Ochroconis gallopava</i> (W.B. Cooke) de Hoog	0.1	0.1	<0.1	1
*	<i>Oidiodendron griseum</i> (Robak) Melin & Nanf.	0.4	0.1	<0.1	3
*	<i>Ophiostoma nigrocarpum</i> (Davidson) de Hoog	0.1	0.1	<0.1	1
*	<i>piceae</i> (Munk) H. & P. Sydow	0.2	0.1	<0.1	4
*	<i>Ovadendron sulphureo-ochraceum</i> (van Beyma) Sigler & Carmichael	0.2	0.2	<0.1	2
*	<i>Paecilomyces carneus</i> (Duchè & Heim) A.H.S. Brown & G. Sm.	0.1	0.1	<0.1	2
	<i>fumosoroseus</i> (Wize) A.H.S. Brown & G. Sm.	0.1	0.1	<0.1	3
	<i>lilacinus</i> (Thom) Samson	0.7	0.1	0.1	9
	<i>marquandii</i> (Masse) Hughes	0.3	0.1	<0.1	4
*	<i>niveus</i> Stolk & Samson	0.1	0.1	<0.1	2
*	<i>suffultus</i> (Petch) Samson	0.2	0.2	<0.1	1

Table 1. Continued

	Load			F
	max	min	mean	
<i>Penicillium aurantiogriseum</i> Dierckx var. <i>aurantiogriseum</i>	0.2	0.1	<0.1	3
<i>brevicompactum</i> Dierckx	17.9	0.1	2.5	12
* <i>camembertii</i> Thom	0.2	0.1	<0.1	2
* <i>charlesii</i> Smith	0.1	0.1	<0.1	1
* <i>citreonigrum</i> Dierckx	0.2	0.1	<0.1	3
<i>citroviride</i> Biourge	0.1	0.1	<0.1	2
<i>fellutanum</i> Biourge	0.2	0.1	<0.1	2
<i>frequentans</i> Westling	0.3	0.1	<0.1	3
<i>funiculosum</i> Thom	0.2	0.1	<0.1	4
<i>griseofulvum</i> (Dierckx) Galeotti	0.1	0.1	<0.1	1
<i>implicatum</i> Biourge	0.4	0.1	<0.1	4
<i>janthinellum</i> Biourge	0.2	0.2	<0.1	1
* <i>jensenii</i> Zaleski	1.3	0.1	0.5	6
<i>lpidosum</i> Raper & Fennell	0.1	0.1	<0.1	1
* <i>melinii</i> Thom	0.1	0.1	<0.1	1
<i>multicolor</i> Grig-Manoil & Porad	0.1	0.1	<0.1	1
* <i>nigricans</i> (Bain.) Thom	0.1	0.1	<0.1	1
<i>ochrochloron</i> Biourge	0.1	0.1	<0.1	2
<i>piceum</i> Raper & Fennell	1	0.1	0.1	4
<i>puberulum</i> Bain.	0.1	0.1	<0.1	2
<i>purpureogenum</i> Stoll	0.4	0.1	<0.1	4
<i>raistrickii</i> G. Smith	0.1	0.1	<0.1	1
<i>roquefortii</i> Thom	1.7	0.1	0.1	6
<i>roseopurpureum</i> Dierckx	0.2	0.1	<0.1	4
<i>rugulosum</i> Thom	1.1	0.1	0.5	11
<i>spinulosum</i> Thom	0.2	0.1	<0.1	2
<i>variabile</i> Sopp	0.6	0.1	<0.1	7
<i>vulpinum</i> (Cooke & Massee) Seifert & Samson	0.1	0.1	<0.1	2
<i>Pestalotia</i> sp.	0.1	0.1	<0.1	1
* <i>Phialophora bubakii</i> (Lexa) Schol-Schwarz	0.1	0.1	<0.1	1
* <i>cinerescens</i> (Wollenw.) van Beyma	0.1	0.1	<0.1	2
* <i>cyclaminis</i> van Beyma	0.1	0.1	<0.1	1
* <i>melinii</i> (Nannf.) Conant	1.0	0.4	0.1	3
sp.	0.1	0.1	<0.1	1
<i>Phoma</i> sp.	0.1	0.1	<0.1	1
<i>Rhinochlaia mansonii</i> (Castell.) Schol-Schwarz	0.2	0.1	<0.1	4
<i>pedrosoi</i> (Brumpt) Schol-Schwarz	0.4	0.1	<0.1	6
<i>Rhizopus oryzae</i> Went & Prinsen Geerligs	0.1	0.1	<0.1	1
<i>Scolecobasidium constrictum</i> Abbott	0.2	0.2	<0.1	1
* <i>Scopulariopsis asperula</i> (Sacc) Hughes	0.1	0.1	<0.1	2
<i>brevicaulis</i> (Sacc.) Bain.	0.6	0.1	0.1	11
<i>brumptii</i> Salvanet-Duval	1.4	0.1	0.2	8
<i>candida</i> (Gueguen) Vuillemin	0.4	0.1	<0.1	7
* <i>carbonaria</i> Morton & Smith	0.1	0.1	<0.1	1
<i>chartarum</i> Morton & Smith	0.4	0.1	<0.1	3
* <i>croci</i> van Beyma	0.6	0.1	0.2	10
* <i>koningii</i> (Oud.) Vuillemin	0.7	0.1	<0.1	7
* <i>sphaerospora</i> Zach	0.3	0.1	<0.1	6
<i>Sporothrix</i> sp.	0.1	0.1	<0.1	2
<i>Stachybotrys chartarum</i> (Ehrenb. ex Link) Hughes	0.1	0.1	<0.1	3
<i>Stephanosporium cereale</i> (Thum) Swart	1.9	0.1	0.1	8

Table 1. Continued

	Load			F
	max	min	mean	
<i>Thermomyces lanuginosus</i> Tsiklinsky (sensu Miehe)	0.1	0.1	<0.1	1
<i>Tilletiopsis</i> sp.	0.2	0.1	<0.1	3
<i>Trichophyton mentagrophytes</i> (Robin) Blanchard	0.1	0.1	<0.1	2
<i>terrestre</i> Durie & Frey	0.1	0.1	<0.1	2
sp.	0.2	0.1	<0.1	3
<i>Trichosporon</i> sp.	0.1	0.1	<0.1	2
<i>Trichothecium roseum</i> Link	0.1	0.1	<0.1	1
<i>Trichurus spiralis</i> Hasselbring	0.1	0.1	<0.1	1
<i>Tripaspermum</i> sp.	0.2	0.1	<0.1	2
<i>Tritirachium oryzae</i> (Vincens) de Hoog	0.2	0.1	<0.1	2
* <i>Verticillium lecanii</i> (Zimm.) Viegas	0.3	0.2	<0.1	3
<i>psalliotae</i> Treschow	0.1	0.1	<0.1	3
Yeasts	0.3	0.1	<0.1	9

F, frequency (n months /12); * rare or never recorded species.

Table 2. Thermotolerant species. Values in cfu m⁻³ air

	Load			F
	max	min	mean	
<i>Alternaria alternata</i> (Fr.) Keissler	0.4	0.4	<0.1	1
* <i>Arthrographis cuboidea</i> (Sacc. & Ellis) Sigler	0.4	0.4	<0.1	1
<i>Aspergillus alliaceus</i> Thom & Church	0.8	0.8	<0.1	1
* <i>deflectus</i> Fennel & Raper	0.4	0.4	<0.1	1
<i>flavus</i> Link	0.4	0.4	<0.1	1
<i>fumigatus</i> Fres.	4.6	0.4	0.6	8
<i>nidulans</i> (Eidam) Wint	0.4	0.4	<0.1	1
<i>sclerotiorum</i> Huber	0.8	0.8	<0.1	1
* <i>sulphureus</i> (Fres.) Thom & Church	0.4	0.4	<0.1	1
<i>terreus</i> Thom	1.2	1.2	0.1	1
<i>versicolor</i> (Vuill.) Tiraboschi	0.4	0.4	0.1	3
* <i>Chrysosporium keratinophilum</i> D. Frey ex Carmichael	0.4	0.4	<0.1	2
* <i>queenslandicum</i> Apinis & Rees	0.4	0.4	<0.1	1
sp.	0.4	0.4	<0.1	1
<i>Cladosporium cladosporioides</i> (Fres.) de Vries	0.4	0.4	<0.1	1
<i>Doratomyces purpureofuscus</i> (Fries) Morton & Smith	0.4	0.4	<0.1	1
* <i>Gymnoascus reesii</i> Baranetzky	0.4	0.4	<0.1	1
<i>Microascus cirrosus</i> Curzi	0.4	0.4	0.1	3
<i>Paecilomyces lilacinus</i> (Thom) Samson	0.4	0.4	<0.1	1
* <i>Penicillium jensenii</i> Zaleski	0.4	0.4	<0.1	1
<i>rugulosum</i> Thom	0.8	0.4	<0.1	2
<i>spinulosum</i> Thom	0.4	0.4	<0.1	1
<i>waksmanii</i> Zaleski	0.4	0.4	<0.1	1
<i>Scopulariopsis brevicaulis</i> (Sacc.) Bain.	0.4	0.4	<0.1	2
* <i>croci</i> van Beyma	0.4	0.4	<0.1	1
<i>Thermomyces lanuginosus</i> Tsilinsky	1.2	0.4	0.1	5

F, frequency (n months /12); * rare or never recorded species.

A point of interest that emerges from these comparisons is the number of *Acremonium*, *Chrysosporium*, *Scopulariopsis*, *Malbranchea*, *Paecilomyces* and *Phialophora* species. These are infrequently reported in studies of the air spora. Some have not been reported previously. They are indicated with an asterisk in the Tables, along with numerous others from a wide spectrum of genera.

By contrast, basidiomycetes, *Epicoccum*, *Fusarium* and *Botrytis*, some of the most constant airborne fungi, are absent.

Quantitative comparisons are more difficult for three fundamental reasons. In the first place, most airborne species composition studies have used the exposed plates method, which does not allow evaluation of the fungus load per unit of air volume. In addition, estimates of concentrations vary according to whether propagules or cfu are counted [37]. Lastly, the great instability of the air means that one can never determine whether CH-tolerant entities made up only a fraction of the air spora at the time of sampling, or whether there were fewer propagules of CH-intolerant species in the air when the CH samples were taken. Even so, there appears to be a marked reduction of the load. This is particularly true for *Cladosporium* and *Alternaria* [31]. Direct comparison of concurrently monitored total and CH-tolerant propagules is the only way in which this point can be made clearer.

CH can thus be said to select airborne fungi in some way and give a very characteristic picture of them. Its use is not advisable if a quantitative estimate is sought, but can serve to extend and improve knowledge of the diversity of fungal aerosols. This offers both theoretical and practical advantages. In fungal allergy, for example, the possibility of detecting species that are not widespread and occur in low propagule concentrations may be of substantial utility, since it is well known that once sensitivity is established even small quantities of an allergen are enough to trigger a reaction [38].

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