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The diversity of indoor airborne molds growing in the university libraries in Indonesia

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Abstract. *Rahmawati, Sembiring L, Zakaria L, Rahayu ES. 2018. The diversity of indoor airborne molds growing in the university libraries in Indonesia. Biodiversitas 19: 194-201.* Airborne mold is potentially causing respiratory diseases. The aim of this study was to investigate the diversity of indoor airborne molds isolated from some libraries in Universitas Gadjah Mada (Gadjah Mada University), Yogyakarta, Indonesia based on morphological characteristics. Sampling was conducted in six libraries at Universitas Gadjah Mada (Libraries of Food and Nutrition at Inter-University Center or Pusat Antar Universitas (PAU), Biotechnology at PAU, Faculty of Biology, Faculty of Mathematics and Natural Sciences, Faculty of Master of Management, and Faculty of Geography) by non-volumetric air sampling method. Isolation of indoor airborne molds was conducted by using two petri dishes containing Dichloran 18% Glycerol Agar (DG 18) for each room. Morphological identification of isolates of indoor airborne molds was based on macromorphological and micromorphological characteristics. Isolation and identification were conducted in Laboratory of Microbiology of Food and Nutrition of PAU at Universitas Gadjah Mada. The result showed the diversity of indoor airborne molds, identified to be members of genera *Alternaria, Aspergillus, Aureobasidium, Byssochlamys, Cadophora, Chaetomium, Chrysonilia, Cladosporium, Curvularia, Emericella, Epicoccum, Eurotium, Fusarium, Geomyces, Mucor, Penicillium, Rhizopus, Rhizomucor, Stemphylium, Scopulariopsis, Wallemia,* and *Xeromyces*. Members of genera *Aspergillus, Cladosporium,* and *Penicillium* were the most dominant molds. The results of this study indicate that the presence of molds potentially causes illness for the library users.

Keywords: Airborne mold*, Aspergillus*, Gadjah Mada University, indoor, library

INTRODUCTION

Indoor airborne quality greatly affects human health because nearly 90% of men stay indoors (Fitria et al. 2008). One of the consequences of poor air quality is infectious respiratory diseases, which can be caused by biological, physical, and chemical factors (Sedyaningsih 2011). According to the Health Minister Regulation no 1077 of 2011, the indoor air quality consist of physical, chemical and biological parameters as follows: (i) physical, namely particulate matter concentration, temperature, lighting, relative humidity, and ventilation rate, (ii) chemical, namely the concentration of sulfur dioxide, nitrogen dioxide, carbon monoxide, carbon dioxide, cigarette smoke, formaldehyde, volatile organic compounds, and (iii) biological, namely the concentration of bacteria and fungi, and the airborne germ rate. The maximum threshold for bacteria and fungi is 0 CFU/m^3, and for airborne germ rate < 700 CFU/m^3 (Sedyaningsih 2011). According to Fitria et al. (2008), organisms such as bacteria and mold are known as bioaerosol. Indoor bioaerosol may come from external environment and indoor contamination. Diseases associated with bioaerosol may be hypersensitivity infectious diseases such as the symptoms of Sick Building Syndrome (SBS).

Sick Building Syndrome (SBS) is a disease caused by the condition of the building and is a collection of symptoms based on the experience of the users of the building as long as they are inside the building (Fitria et al. 2008). According to Sedyaningsih (2011) and Heseltine and Rosen (2009), the SBS symptoms can be in the forms of headache, loss of concentration, dry throat, eye irritation and skin allergy. Some forms of SBS-related illnesses are skin and respiratory allergies, eye irritation, nose, and dry mucus, mental fatigue, headache, asthma, cough, flu, and sneezing, and other hypersensitivity reactions. These sympoms suggest that the presence of bio-aerosols in the room can cause illness with SBS symptoms. The most contaminating microorganisms in the room which cause illness with SBS symptoms are molds whose number can reach tens to thousands. Mold can be found in any place where organic material is present and it is easily carried into the room by wind because it has many spores or by the dust of clothing or other material or by insects and other animals from outdoors (Heseltine and Rosen 2009).

One room that has the potential of air pollution problems is the library room because in the room there are many piles of books and shelves that are not always clean, and the ventilation is not good so that the condition will create concentrated dust indoors (Fitria et al. 2008). The dust becomes a substrate for microbes, especially molds

that obtain nutrients from it and they are so easily carried by dust and air in the room. Workers in the library who are exposed to microorganisms may have additional consequences such as infections and mycotoxicoses (Skora et al. 2015). Fitria et al. (2008) found a mold member of the genus *A. fumigatus* in several libraries at University of Indonesia. The mold is known to potentially enter and interfere with the respiratory tract due to its small size and can cause aspergillosis, and so can other members of the genus *Aspergillus* (Abad et al. 2010). This shows that the condition of campus buildings in Indonesia has the potential to cause health problems for students, lecturers, and all campus employees because the air and dust contain molds.

Therefore, it is necessary to conduct research to know the air quality in libraries at Universitas Gadjah Mada (Gadjah Mada University) or UGM, Yogyakarta, Indonesia, which is one of the biggest universities in Indonesia, by looking at the diversity of molds in the room as the first action of disease prevention for library users at UGM.

MATERIALS AND METHODS

Study area

This study was conducted in Universitas Gadjah Mada (Gadjah Mada University) or UGM, Yogyakarta, Indonesia. Sampling was conducted in January 2012 in six libraries at the university, ie. libraries of Food and Nutrition at Inter-University Center or Pusat Antar Universitas (PAU), Biotechnology at PAU, Faculty of Biology, Faculty of Mathematics and Natural Sciences, Faculty of Master of Management, and Faculty of Geography. Sampling and observation of the condition of the libraries were done during working hours (08.00-12.00 WIB).

Procedures

Sampling of indoor airborne molds

The parameters of environmental included temperature and relative humidity of the library measured in succession using thermometer and hygrometer at the time of sampling. The sampling method was conducted by non-volumetric air sampling (Samson et al. 2010) using two petri dishes containing Dichloran 18% Glycerol Agar (DG 18) media for each room. The petri dishes were opened for 30 minutes in each library with the aim that the media were contaminated by indoor airborne molds. One petri dish was placed on a reading table and the other on a bookcase in each library. The petri dishes were closed after 30 minutes, then incubated at room temperature in the laboratory for 1 week, then each growing mold was transferred to new media to be isolated and purified.

Isolation and purification of indoor airborne molds

Indoor airborne molds that have been taken from the library were further isolated by moving each mold from the growing colony to the appropriate purification media, namely Malt Extract Agar (MEA), Dichloran 18% Glycerol Agar (DG 18), or Czapek Yeast Extract Agar + 20% Sucrose (CY20S) by a three-point method, then incubated for more than 5 days to 1 week at room temperature. Then, the mold was re-purified by a single spore isolation method by taking a bit of mold with an inoculation needle, then spreading it onto a new medium and incubated for 2-4 days at room temperature or until the mold spores had grown or had visible newly-growing hyphae threads. Then the spore sprouting apart or a small collection of hyphae from the single spore was inoculated into a tube containing MEA, DG 18 or CY20S media, then incubated at room temperature and then pure culture was used for identification.

Identification of indoor airborne molds by profile matching method based on morphological characteristics

The purified mold isolates were further identified by growing them on identification media: MEA, DG18, or CY20. Molds growing on the media were identified based on macro-morphological characteristics, namely color, shape, and colony structure on media in petri dishes, and colony diameter. The mold was subsequently identified micro morphologically by preparing wet specimens on microscope slides using a small amount of mycelium and the spores were taken with an inoculation needle and then placed on top of the lactophenol sprayed glass object, then sprinkled with a bit of ethanol, then covered with a prepolymer glaze. The specimens on the slides were observed under a light microscope. These micromorphological characteristics observed included fruit body structure, somatic structure, and mold reproduction structure. Identification at the genus level was done using profile matching method by comparing the mold morphology obtained with description in two identification books, i.e. Gandjar et al. (1999) and Samson et al. (2010).

RESULTS AND DISCUSSION

The diversity of indoor airborne molds based on the morphological characteristic identification

The diversity of indoor airborne molds that have been successfully isolated using DG18 media in six library spaces available at Universitas Gadjah Mada (UGM) can be seen in Table 1. Based on the morphological characteristic identification, indoor airborne molds that have been successfully isolated, purified, and identified, 88 isolates were found in six libraries: 16 from the library of Food and Nutrition at Inter-University Center or Pusat Antar Universitas (PAU), 14 from the library of Biotechnology at PAU, 14 from the library of Faculty of Biology, 12 from the library of Faculty of Mathematics and Natural Sciences, 13 from the library of Faculty of Master of Management, and 19 from the library of Faculty of Geography. There were 22 genera of 88 isolates, including members of the genera *Alternaria, Aspergillus, Aureobasidium, Byssochlamys, Cadophora, Chaetomium, Chrysonilia, Cladosporium, Curvularia, Emericella, Epicoccum, Eurotium, Fusarium, Geomyces, Mucor, Penicillium, Rhizopus, Rhizomucor, Stemphylium,*

Scopulariopsis, Wallemia, and *Xeromyces* (Table 1 and Figure 1).

The percentage of presence of indoor airborne molds in libraries at UGM can be seen in Figure 2, which shows that the most dominant genera of molds were *Aspergillus, Cladosporium,* and *Penicillium*.

Environmental factors that affect the presence of indoor airborne molds in the libraries at UGM

The presence of indoor airborne molds in the libraries at UGM was supported by the condition of the libraries, especially the temperature and relative humidity of the libraries. The temperature of the libraries at UGM ranged between 24ºC and 34ºC and the relative humidity 18-58%.

Discussion

The common molds found in this study were members of the genera *Aspergillus* (29.50%), *Cladosporium* (18.18%), and *Penicillium* (17.04%). They could be found in all the libraries at UGM (Table 1 and Figure 2). Kuhn and Ghannoum (2003), Sko´ra et al. (2015), Borrego and Perdomo (2016), and Islamiati et al. (2017) also found that members of the genera *Aspergillus, Cladosporium,* and *Penicillium* were predominant indoor airborne molds. Alhussaini et al. (2015) also found members of the genus *Cladosporium* (12.4%) isolated from all studied sites and found almost every month. Flannigan *et al*. (2011) and Alhussaini et al. (2015) also state that the three members of the molds are commonly found indoors and outdoors. Harkawy et al. (2011) and Hempel et al. (2014) also found the genera *Aspergillus* and *Penicillium* in libraries but did not find genus *Cladosporium*. They didn't find other molds found in this study, namely members of genera *Byssochlamys, Cadophora, Eurotium, Emericella, Xeromyces*, etc. This shows that not all molds can be found in all rooms. The presence of airborne molds can be affected by the presence of substrate, temperature, and relative humidity (Flannigan et al. 2011; Park et al. 2013). According to Borrego and Perdomo (2016), the most favorable conditions for microbial growth vary, depending on the species. According to Samson et al. (2010), the molds can reproduce sexually. Sexual reproduction is done by molds in extreme conditions. The fungi are suspected to have been present in the library room at UGM for a long time. This is in accordance with Baudisch et al. (2009) who also found a member of the genus *Eurotium* and said that in addition to temperature and humidity factors, dust that in the room affected the presence of molds.

Some of the indoor airborne molds found the library rooms at UGM were a new entry into the libraries because it was carried by air coming from outside the room, but others have been there for a long time. The indoor airborne molds can survive for a long period of time in the libraries because in the library rooms there are substrates derived from organic molecules as a source of nutrients for molds, including dust, books and wooden bookcase containing cellulose, glue from rubber and resin materials, or from animals such as glue, as well as other particulates that exist in the library rooms at UGM. Not all dust or indoor particles can be removed daily, such as those at the ceilings, in books, on bookcases, and elsewhere in hard-to-reach places to clean up. According to Fitria et al. (2008), the water tanks or water baths in damaged or dirty bathrooms, as well as damp air, are sources of mold contamination.

Table 1. Total number of indoor airborne mold isolates that have been successfully isolated in each library at Universitas Gadjah Mada, Yogyakarta, Indonesia

Genera	Library	Total isolates
Aspergillus	Food and Nutrition	6
	Biotechnology	4
	Biology	3
	Mathematics and Natural Sciences	4
	Master of Management	4
	Geography	5
Eurotium	Geography	1
Emericella	Master of Management	1
Byssochlamys	Food and Nutrition	1
	Biotechnology	1
	Mathematics and Natural Sciences	1
Alternaria	Food and Nutrition	1
Rhizopus	Food and Nutrition	2
	Biotechnology	1
Penicillium	Food and Nutrition	3
	Biotechnology	1
	Biology	6
	Mathematics and Natural Sciences	1
	Master of Management	1
	Geography	3
Cladosporium	Food and Nutrition	2
	Biotechnology	2
	Biology	3
	Mathematics and Natural Sciences	3
	Master of Management	2
	Geography	4
Chaetomium	Food and Nutrition	1
Aureobasidium	Biotechnology	1
Curvularia	Biotechnology	3
Stemphylium	Biotechnology	1
Scopulariopsis	Biology	1
Fusarium	Biology	1
	Mathematics and Natural Sciences	2
	Geography	2
Chrysonillia	Mathematics and Natural Sciences	1
Mucor	Master of Management	2
Wallemia	Master of Management	1
Geomyces	Master of Management	1
	Geography	1
Epicoccum	Master of Management	1
Xeromyces	Geography	1
Cadophora	Geography	1
Rhizomucor	Geography	1
Total isolates		88

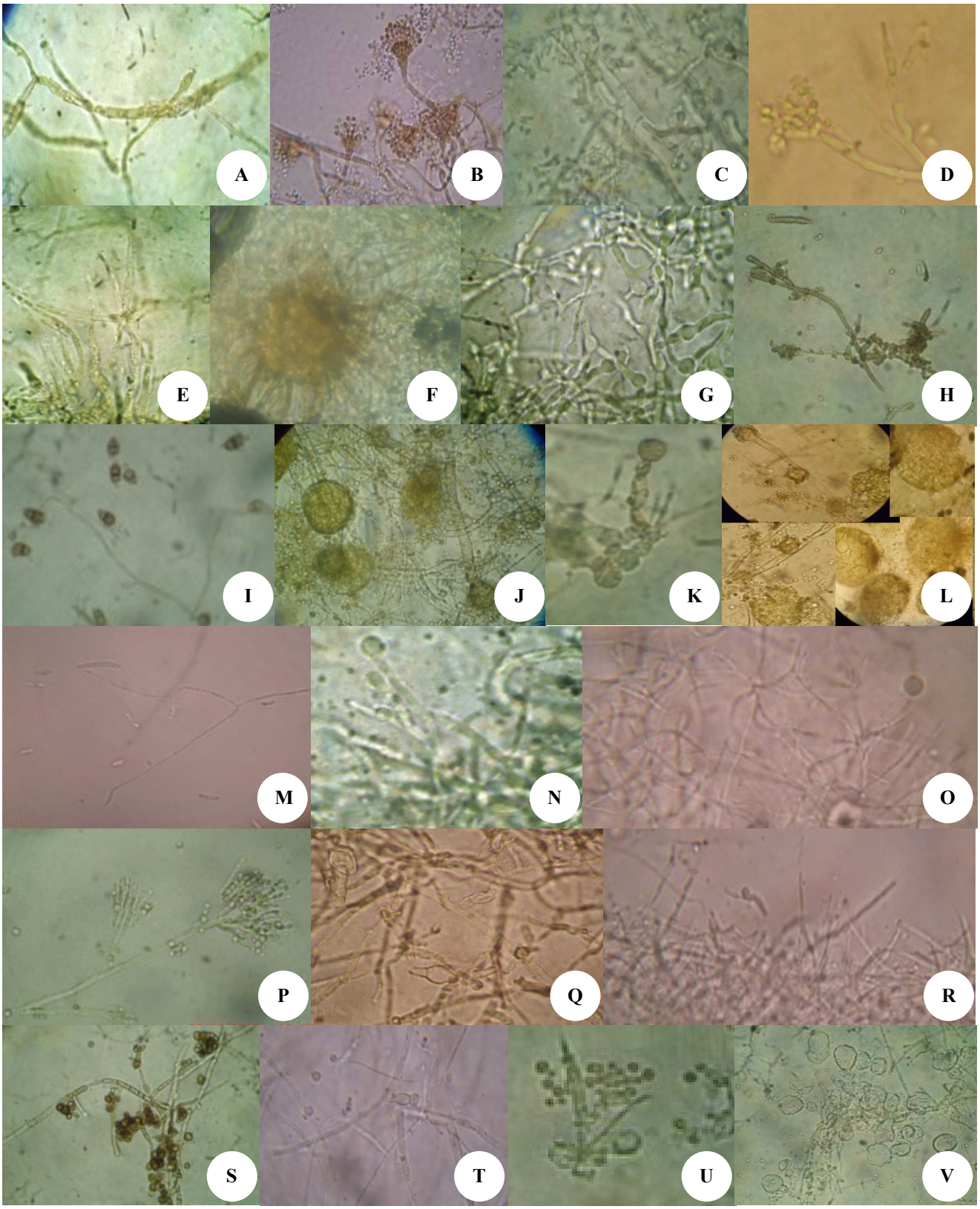

Figure 1. Indoor airborne molds in libraries at the Universitas Gadjah Mada, Yogyakarta, Indonesia. A. *Alternaria*, B. *Aspergillus*, C. *Aureobasidium*, D. *Byssochlamys* E. *Cadophora*, F. *Chaetomium,* G. *Chrysonillia,* H. Cladosporium, I. *Curvularia*, J. *Emericella*, K. *Epicoccum*, L. *Eurotium*, M. *Fusarium*, N. *Geomyces*, O. *Mucor*, P. *Penicillium,* Q. *Rhizopus*, R. *Rhizomucor*, S. *Stemphylium*, T. *Scopulariopsis*, U. *Wallemia*, V. *Xeromyces*

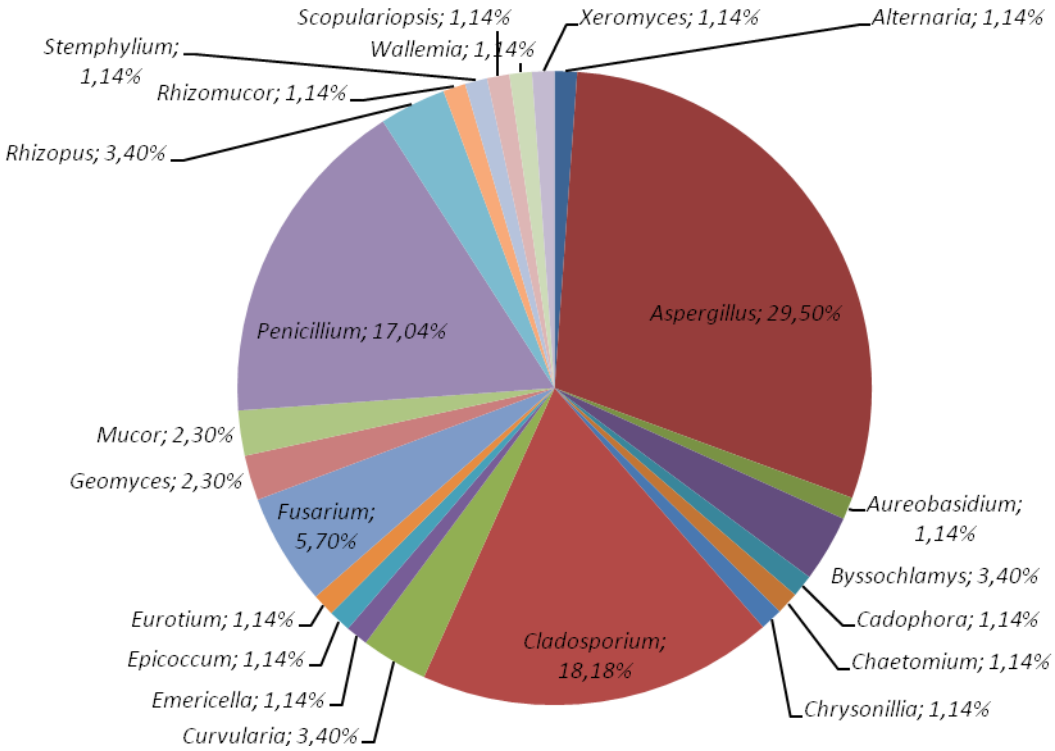

Figure 2. Percentage of indoor airborne molds genera from libraries at Universitas Gadjah Mada, Yogyakarta, Indonesia

Alhussaini et al. (2015) state that indoor airborne molds usually enter a building through outdoor air intakes of the heating, ventilation, and air conditioning system, through doors and windows, and as contaminants on building materials. If elevated moisture conditions exist for a sufficient time in a building, mold growth and sporulation may occur. Harkawy et al. (2011) also state that the genera *Aspergillus* and *Penicillium* are predominantly found in libraries, which can be found at paper, leather, and wood biodeteriogens from indoor air, outdoor air, or settled dust. According to Samson et al. (2010) and Flannigan et al. (2011), indoor airborne molds, primarily members of the genera *Penicillium* and *Aspergillus* have light, small, plentiful spores which are easily airborne and dust borne. Heseltine and Rosen (2009) state that mold is easily carried into the rooms by wind because it has a lot of mycelium and light spores and can be carried away by clothes and other materials, brought into the room by insects and other animals from outdoor. Thus, the three genera molds that exist in the libraries at UGM are thought to come from outdoors, attached to the dust carried by the wind into the rooms, and they thrive indoors because of its conidiophore which makes it possible to produce spores (conidia) that are lightweight and numerous so as to survive in the air and to be attached to the substrate indoors.

Flannigan et al. (2011) state that every day spores can enter the rooms when windows and doors are open. According to Borrego and Perdomo (2016), the external dust enters the rooms through the holes of the natural cross-ventilation system. Windows or ventilation of the library of the Food and Nutrition at Pusat Antar Universitas (PAU) were open, enabling molds to enter the rooms every day and can survive and multiply their spores and mycelium indoors for a long period of time. It is therefore very likely that members of the genus *Aspergillus* are found in the library of the Food and Nutrition at Pusat Antar Universitas (PAU) (Table 1) because they have small, light, dry, and numerous spores, which are easily carried by air into the rooms. Although other library windows were closed, mold could enter the rooms when the doors were open, allowing the molds to stay indoors for a long time and multiply their spores and mycelium inside the rooms in the long run because the ventilation system was not good. The library at the Faculty of Biology UGM had a poor air exchange system because it did not use air conditioners, only fans which were rarely cleaned, and the windows were closed. There was a lot of dust, indoor toilets, and the room temperature and humidity were suitable for the growth of mold, so it is possible to find many members of the genera *Penicillium* and *Aspergillus* which both have light, small, plentiful, and easily airborne spores.

In addition to strains belonging to the genera *Aspergillus, Cladosporium*, and *Penicillium*, other molds found indoors are also thought to have originated from outdoors, since naturally molds generally live on organic substrates, in soil, plants, animals, or human tissues, and subsequently moving together with the substrate and carried by air into the rooms (Flannigan et al. 2011). The

mold isolates found in the libraries at UGM are suspected to be molds that have long been indoors because they are in dust or particulates contained in parts of the rooms that are not always cleaned and can come from outdoors or animals such as insects that enter the libraries or carried away by dust stuck in the clothes of visitors. According to Flannigan et al. (2011), mold can enter the rooms due to contamination of human clothing and animal fur coming into the rooms.

Outdoor airborne particles can bring molds into the library because the six libraries in this study are located within campuses close to human settlements, hospital, highways and trees. The condition allows the molds to be carried by air into the library rooms along with dust or particulates that have polluted the environment around the campus. Dust and spores or mycelium molds found in the libraries are allegedly to be derived from household activities of surrounding communities, trees, student activities in the lecture halls, and laboratory activities around the campus, such as dust that carries molds of research materials, scattered into various rooms. In fact, Sidar et al. (2016) who conducted study in the same year with this study in hospital rooms in Yogyakarta near UGM found that members of the genera *Aspergillus, Cladosporium,* and *Penicillium* were also the dominant molds in the air of the hospital rooms. Harkawy et al. (2011) have also found molds of the genera *Acremonium, Alternaria, Aspergillus, Penicillium, Wallemia* from outdoors, found on paper and wood biodeteriogens. Molds of the genera *Penicillium, Chaetomium, Aspergillus, Cladosporium, Stemphylium (Ulocladium), Alternaria, and Aureobasidium* have the potential to be cellulolytic, lipolytic, and proteolytic. Borrego and Perdomo (2016) also state that members of the genus *Alternaria* can be found in soil and on the plants, and it is possible that the vegetation around the building contributes to the presence of these fungal genera because they are transported by the air into the building.

The presence of members of the genera *Cladosporium, Aspergillus,* and *Penicillium* in the libraries at UGM was also supported by temperature and relative humidity at the time of sampling. There was an effect of humidity and temperature on microbial concentration in the air in majority of the facilities tested (Sko´ra et al. 2015). Temperature and relative humidity are important factors influencing the number of spores in the water (Luo et al. 2016). Indoor relative humidity (RH) and temperature vary spatially and temporally in buildings, and so the locations and frequency of measurements can have a significant impact on the value of RH (Dedesko and Siegel 2015). The sampling was done during rainy season, and the air temperature in the libraries was 24-34ºC and relative humidity 18-58%. According to Alhussaini et al. (2015), the density of mold especially *Cladosporium* spp. during the investigation of seasonal variation was affected by month and site. According to Borrego and Perdomo (2016), the weather condition in tropical countries is one of the factors responsible for the indoor microbial behavior. The high relative humidity and temperature recorded during the rainy season especially favor the development of mold propagules and increase the level of viable conidia in the atmosphere.

According to Gandjar et al. (1999), Samson et al. (2010), and Flannigan et al. (2011), the three members of the molds can also grow at temperature of 20-35ºC, so categorized as mesophylic. Members of the genus *Aspergillus* can generally grow at temperatures ≤20-≥50ºC and humidity ≤90% (Flannigan et al. 2011; Samson et al. 2010), and there are even members of the genus *Aspergillus* that can grow below 20ºC to 10ºC, so categorized as psychrotolerant-mesophylic, and temperatures above 35ºC to above 50-55ºC, thus categorized as thermotolerant-mesophylic, such as members of the genus *A. fumigatus*. Members of the genus *Penicillium* can live in temperature of 20-35ºC and humidity ≤90% (Flannigan et al. 2011; Samson et al. 2010).

Other indoor airborne molds found in libraries at UGM are members of the genera *Alternaria, Aureobasidium, Byssochlamys, Cadophora, Chaetomium, Chrysonilia, Curvularia, Epicoccum, Fusarium, Geomyces, Mucor, Rhizopus, Rhizomucor, Scopulariopsis, Stemphylium, Wallemia,* and *Xeromyces*. Members of the genus *Alternaria* live at temperature from 25ºC (Gandjar et al. 1999) to 35ºC (Samson et al. 2010), *Aureobasidium* 4-35ºC, *Byssochlamys* 30-50ºC, *Cadophora* 20-25ºC, *Chaetomium* 18-40ºC, *Chrysonilia* 25-35ºC, *Curvularia* 24-30ºC, *Epicoccum* 3-45ºC, *Fusarium* 25-37ºC, *Geomyces* 18-30ºC, and *Mucor* 5-37ºC. Other molds such as members of the *Rhizopus* can grow at temperature of 5-44ºC, *Rhizomucor* 21-62ºC, *Scopulariopsis* 5-40ºC, *Stemphylium* 5-25ºC, *Wallemia* 23-36ºC, and *Xeromyces* at 25-30ºC (Samson et al. 2010). This shows that the room temperature in the libraries at UGM supports the growth and development of the molds.

The ability of indoor airborne molds to survive is also influenced by the relative humidity factor (Baudisch et al. 2009). The low relative humidity in libraries at UGM can support the growth of the molds because according to Flannigan et al. (2011), there are molds that can grow in the relative humidity of ≤90%, even < 70%. In addition to having small, light and dry spores, indoor airborne molds, primarily members of the genera *Aspergillus*, *Cladosporium*, and *Penicillium,* can live in dry conditions under 90% RH (xerophilic), so that these three members of the molds are predominantly found in the room. Members of the genera *Eurotium* and *Emericella* (anamorph *Aspergillus*), a xerophilic molds with high tolerance to water stress can produce ascospores in ascomata to survive during water shortages (Samson et al. 2010; Micheluz et al. 2015). Members of the genera *Eurotium* and *Emericella* are highly xerophilic molds because they can live in very dry conditions (Samson et al. 2010; Flannigan et al. 2011). Members of the genera *Eurotium* and *Emericella* were found in the libraries that had the lower humidity than the other libraries at UGM. Members of the genus *Eurotium* were found in the air around the bookcase in the library of Faculty of Geography which had RH of 26% and *Emericella* in the air around the reading table in the library of Faculty of the Master of Management with RH of 28%.

These conditions were very dry (xerophilic) so that both members of the genera can survive indoors.

Generally, members of the genera *Geomyces*, *Mucor*, and *Rhizopus* are categorized in the hydrophilic group because they can live indoors with RH of ≥90% (Flannigan et al. 2011), but the results showed the presence of all three members of the genus from indoor air with RH of ≤90%. Members of the genus *Geomyces* were found in the air around the reading table in the library of Faculty of Master of Management with RH of 28% and in the air around the bookcase of Faculty of Geography with RH of 26%. Members of the genus *Mucor* were found in the air around the reading table with RH of 28% and bookcase with RH of 30% in the library of Faculty of Master of Management. Members of the genus Rhizopus were found in the air around the reading table with RH of 56% and bookshelf with RH of 56% in the Food and Nutrition at Pusat Antar Universitas (PAU) and around the reading table with RH of 52% in the library of Biotechnology. These data suggest that the strains of the genera *Geomyces*, *Mucor*, and *Rhizopus* are xerophilic tolerant (xero-tolerant) because they can live indoors with humidity of ≤90%. Members of the molds were allegedly to have long been indoors or new entry into the room because they were carried by the outdoor airborne that came into the rooms. Thus, the molds found in this study can be categorized into xerophilic molds as they are capable of living in dry conditions or relative humidity of ≤90%.

Indoor airborne molds found in UGM libraries, such as members of the genera *Alternaria, Aureobasidium, Aspergillus, Chaetomium, Chrysonilia, Cladosporium, Mucor,* and *Penicillium,* can potentially cause disease in humans. Skora et al. (2015) state that microorganisms are potential pathogens according to classifications of the Directive UE 2000/54/WE, Regulation of the Minister of Health in Poland dated 22 April 2005, the European Confederation of Medical Mycology (BSL) and the Institute of Rural Health in Lublin (IMW). Indoor airborne molds such as members of the genera *Aspergillus, Alternaria, Penicillium, Cladosporium* (Vesper 2007; Heseltine and Rosen 2009; Samson et al. 2010; Knutsen et al. 2012; Luo et al. 2016), *Eurotium* (Abbott 2004: Vesper 2007; Baudisch et al. 2009; Heseltine and Rosen 2009; Samson et al. 2010), *Rhizopus, Chaetomium, Aureobasidium, Curvularia, Scopulariopsis, Fusarium*, *Geomyces, Epicoccum, Rhizomucor* (Flannigan et al. 2011), and *Mucor* (Heseltine and Rosen 2009) may cause respiratory tract diseases or other diseases in humans. In addition, according to Samson et al. (2010), other molds that can also cause disease in humans are members of the genera *Emericella, Byssochlamys,* and *Wallemia*.

In addition to biological and physical factors, chemical factors can also affect the health of library users (Sedyaningsih 2011). The room cleaning materials containing chemical compounds in the libraries can also affect the health of library users, especially when volatile chemical compounds are inhaled by users of the libraries. Based on the information obtained during sampling, one of the chemical compounds used in the libraries at UGM, especially in libraries of Faculty of Mathematics and Natural Sciences and Faculty of Biology is pine oil (wipol). According to Mironescu et al. (2009), pine oil is biocidal that is volatile, but based on the results of his research this compound has a low biocidal action to members of the genus *Aureobasidium* and middle biocidal action against *Alternaria*. This is thought to be reason why each the two genera only had one isolate found in this study (in Biotechnology at PAU and Food and Nutrition at PAU).

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