INVESTIGATIONS INTO AIR POLLUTANT CONCENTRATIONS ACROSS INNER SYDNEY AND THEIR RELATIONSHIPS WITH URBAN FORESTRY

A thesis submitted by Peter J Irga to the School of Life Sciences, University of Technology Sydney, in partial fulfilment of the requirements of the degree of Doctor of Philosophy

July 2016
Statement of Original Authorship

I certify that this thesis has not already been submitted for any other degree and is not being submitted as part of the candidature for any other degree.
I also certify that the thesis has been written by me, and that any help I have received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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Date: 17th July 2016

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Abstract

It is widely understood that the activities of plants can influence the concentration of ambient air pollutants. The research presented here assessed urban air pollution across Sydney, and examined whether higher concentrations of urban forests were associated with quantifiable effects on ambient air pollutant levels. The findings indicate that areas with higher concentrations of urban forests may lead to better air quality with respect to reduced ambient particulate matter, however, if the greenspace was composed of grass, increased fungal concentrations were observed. A further investigation was made, aimed at assessing the potential contribution of senescent leaves to the diversity of airborne fungal propagules during autumn. The fungi aerosolized from autumn leaf samples were commonly found in the autumn air samples, thus it is likely that phyllospheric fungi present on deciduating leaves contribute to the aeromycota of these urban areas. An additional investigation studied the diversity of aeromycota associated with forty urban bird roosts. Associations were established between *Rhodotorula* and Pacific black ducks, wood ducks, myna birds and miner birds. Further associations were established between *Penicillium*, *Scopulariopsis* and *Cunninghamella* and pigeons, sparrows and swallows. Indoor air quality in buildings located within the same sampling sites as used in the first study, were used to make a comparison across building ventilation types. Generalising, it was found that the indoor air quality of a typical Australian office building does not pose a health issue to occupants. As the air in naturally ventilated buildings largely resembles that of the proximal outdoor air, urban forests will influence the composition of air pollutants within these buildings, both positively and negatively. The results combined, demonstrate that urban forests does influence air pollutants substantially, either through the reduction of ambient particulate matter, or the facilitation of bioaerosols either directly or indirectly. In light of these results, I propose that the research methods developed here can be used for other field studies related to air pollutants, and that the data here not only contributes new valuable data on the distribution and behaviour of air pollutants but also identifies possible sources and preventative mechanisms.
Keywords

Aeromycota
Airborne fungi
Allergy
Asthma
Avian droppings
Bioaerosols
Environmental sources
Guano
I/O ratios
Leaf surface fungi
Mechanical ventilation
Occupational health
Offices
Particulate matter
Phylloplane
Public health
Rhodotorula
Risk assessment
Seasonal
Sydney
Street trees
Urban ecology
Workplace safety
Zoonosis
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Preface

This thesis consists of nine chapters. Chapters two to six are derived from journal articles that have been peer reviewed and published, presented in logical order. I have presented them similar to their published form; consequently, some repetition occurs in regards to themes and background, and formatting and referencing may differ slightly across chapters. To prevent unnecessary duplication, a single reference list has been provided at the end of the thesis.

This thesis is a compilation of my own work with guidance from my supervisors and additional assistance from others. I conceptualized the research, designed the experiments including choice of methods, and instrumentation, conducted all data collection and analysis, and wrote the manuscripts. My supervisors and co-authors proof-read and edited the final manuscript versions. Publication details are listed below and contributions of co-authors are detailed at the start of each chapter.
List of peer reviewed publications

The publications presented here form chapters 2-6.

Irga, P. J., M. D. Burchett and F. R. Torpy (2015). Does urban forestry have a quantitative effect on ambient air quality in an urban environment? *Atmospheric Environment* **120**: 173-181. [https://dx.doi.org/10.1016/j.atmosenv.2015.08.050](https://dx.doi.org/10.1016/j.atmosenv.2015.08.050)

Irga, P. J., and F. R. Torpy (2016). A survey of the aeromycota of Sydney and its correspondence with environmental conditions: grass as a component of urban forestry could be a major determinant. *Aerobiologia*. **32**: 171-186. [https://dx.doi.org/10.1007/s10453-015-9388-0](https://dx.doi.org/10.1007/s10453-015-9388-0)


Other peer reviewed publications
The publications presented here were published during the candidature but do not form part of this thesis


List of conference presentations
The presentations presented here resulted from this work, however have not otherwise been included in this thesis


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Analysis of Similarity  
Analysis of Variance  
Antigen-presenting cells  
Canonical correspondence Analysis  
Carbon dioxide  
Carbon monoxide  
Central Business District  
Colony Forming Units  
Constant air volume  
Mixed model ventilation systems methods  
General Linear Model  
Heating, Ventilating and Air Conditioning systems  
Indoor/outdoor  
Local Government Area  
Major histocompatibility complex II  
Natural ventilation  
New South Wales Environmental Protection Agency  
Centralised mechanical ventilation systems  
New South Wales Office of Environment and Heritage  
Nitric oxide  
Nitrogen dioxide  
Oxides of nitrogen  
Non-metric multidimensional scaling  
Nota Bene  
Oxides of sulfur  
Particulate matter  
Particulates less than 10 micrometres in size  
Particulates less than 2.5 micrometres  
Pathogen-associated molecular patterns  
Polycyclic aromatic hydrocarbons  
Repeated Measures General Linear Model Analysis of Variance  
Reuter Centrifugal air sampler

ANOSIM  
ANOVA  
APCs  
CCA  
CO2  
CO  
CBD  
CFU  
CAV  
CVS  
GLM  
HVAC  
I/O  
LGA  
MHC  
NV  
NSW EPA  
MVS  
OEH  
NO  
NO2  
NOx  
nMDS  
NB  
SOx  
PM  
PM10  
PM2.5  
PAMPS  
PAH  
RM GLM ANOVA  
RCS
Sabouraud Dextrose Agar (SDX)
Sick Building Syndrome (SBS)
Standard Error of the Mean (± SE or ± SEM)
Statistical Package for the Social Sciences (SPSS)
Sulfur dioxide (SO₂)
Tapered Element Oscillating Microbalance (TEOM)
The National Environment Protection Ambient Air quality Measure (Air - NEPM)
Toll-like receptors (TLR)
Total Suspended Particulate Matter (TSP)
United States of America (USA)
Urban Air Pollution (UAP)
Urban Forest Effects Model (UFORE)
Volatile Organic Compounds (VOCs)
World Health Organization (WHO)