Characterisation of volatile constituents of six native New Zealand ferns and changes in volatile emission in response to herbivore, mechanical wounding and phytohormone treatments.

A thesis presented in partial fulfilment of the

requirements for the degree of

Master of Science

in

Ecology

At Massey University, Manawatū Campus, New Zealand

Keylee Soriano

2018

Abstract

Evolution has led to the development of countless defence strategies in terrestrial plants to deal with the threat of herbivory and disease. The production of specialised morphological structures, such as thorns and trichomes, is a prominent defence mechanism that directly deters potential herbivores. However, plants are capable of enlisting the aid of natural predators and parasites of attacking herbivores as a means of indirect defence, through the production and release of volatile organic compounds. This has prompted much research into the regulation and ecological roles of volatile organic compounds in many higher plant groups. However, similar studies are seldom in lower plants such as the Monilophytes thus we know very little concerning the ecological importance of plant emitted volatiles in this group. In this study, I investigated the volatile compounds released by six abundant native fern species using direct solvent extraction and headspace collections, and characterized the volatile emissions under natural herbivory, phytohormone treatment, and mechanically induced stress. Solvent extracts and headspace collections were analysed using gas chromatography coupled with mass spectrometry allowing the quantitative and qualitative description of the volatile profiles. These results were then used to relate volatile emission to the growth mode and other potential defence strategies of these species. A total of 15 volatile compounds were identified over the course of this thesis with links to fern physiology. Quantitative results revealed no differences in emissions under phytohormone treatment or artificially induced stress. The comparison of two methods, solvent extraction and headspace sampling, reveals the limitations the solvent extraction method has on elucidating fern-insect interactions. Research on fern volatiles could give insight into the evolution of anti-herbivore defence mechanisms in plants and the interactions between native ferns and arthropod communities. Potential applications of research in fern chemistry include pharmaceutical or perfumery uses and fern conservation, which should be incentives for further work. The results and conclusions made from this thesis does not only contribute to the limited pool of knowledge in this field of research but may also serve as a foundation for future studies.

Acknowledgements

This thesis would not have been possible without the support and input of several people. I would like to express, first and foremost, my gratitude and appreciation to my supervisor Dr. Andrea McCormick who not only introduced me to this amazing field of research but also encouraged and advised me all throughout my Masters. A huge thank you for proof-reading and providing feedback over the course of writing my thesis, your enthusiasm in particular, in addition to your expertise in this subject were the driving forces behind me completing this dissertation. Despite your ever-busy schedule, you always managed to make time for me and others whenever your door was open which I, and very likely the others as well, will always be grateful for. Those of whom I also owe a great deal of thanks for their contribution are Paul Barrett, the technical manager for the Ecology department, for not only procuring the equipment I needed for my experiments but also swiftly resupplying consumables whenever they were exhausted. John Sykes, primary technician for the Environmental Engineering Laboratory, for allowing me to use their laboratory's GC-MS and for also maintaining and servicing the machine whenever it occasionally misbehaved. Shaun Nielsen, an ecology technician, for his advice in my herbivory experiments and his willingness to get dirty and muddy for the sake of catching my wetas, I cannot thank you enough for this. Dr. Gillian Rapson, a senior lecturer in Ecology, who graciously lent me some space for my ferns in her nursery. I would like to give my gratitude to the entire Chemical Ecology group, past and present, of which I am apart of for their continuous support, encouragement and assistance throughout my studies. I would like to acknowledge Massey University overall for providing the services needed to accomplish my Masters studies. Lastly, I would like to express my thanks to my family, my parents in particular, for supporting me all through my tertiary education be it financially or emotionally. I could not have made it without you. Looking back on the past several years it has certainly been quite an enjoyable experience, I have learnt many things and have grown and matured as a person. To everyone, both directly and indirectly, involved in my journey at Massey University it has been an absolute pleasure working and interacting with you all and I look forward to what comes next.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

VOC -	Volatile Organic Compounds
CT -	Control
JA -	Jasmonic Acid
PD -	Mechanical Damage
W –	Weta
PVH -	Passion Vine Hopper
GC-MS -	Gas Chromatography–Mass Spectrometry
AB -	*Asplenium bulbiferum*
AO -	*Asplenium oblongifolium*
CD -	*Cyathea dealbata*
CM -	*Cyathea medullaris*
DS -	*Dicksonia squarrosa*
MP -	*Microsorum pustulatum*